SCIENCE ABSTRACTS.

Section A.—PHYSICS.

NOVEMBER 1919.

GENERAL PHYSICS.

1342. *The Newall Measuring Devices.* (Engineering, 108. pp. 104–105, July 25, 1919.)—Recent improvements in the products of this firm are here explained. Three kinds of gauges are mentioned: (*a*) Spherical-ended rods, (*b*) end-measuring blocks, (*c*) cylindrical gauges. In the case of the rods the fixed insulating handles, so well known by users of the Newall gauges, are now omitted, as experience shows that these handles produce unstable conditions in the rod. Also in the case of the blocks the sectional dimensions have been modified so as to be more convenient for bulk manufacture.

New features in the Newall micrometers and standard measuring machines are also mentioned. In particular, the measuring machine has been modified in four particulars. (1) A compensator. This involves a thread with a flat top on which undulations are made to correspond with inaccuracies of pitch. By this means a forward or backward movement is given to the arm on which the vernier is fixed. (2) An adjustable vernier arm for setting zero to any convenient place. This peculiarity of the Newall machine is now well known to metrologists. (3) A new design of V-blocks for supporting gauges under measurement. (4) A new heavier form of bed-plate.

Curves are given showing the accuracy found in machines sent to the National Physical Laboratory. Eleven plates and figures are given to illustrate this article. P. E. S.

1343. *Instrument for Measuring Pressures in a Gun.* **A. G. Webster** and **L. T. E. Thompson.** (Nat. Acad. Sci., Proc. 5. pp. 259–268, July, 1919.)—The authors have developed an apparatus which shows not only the maximum pressure in a gun barrel, but also the pressure at any time while the projectile is in the barrel; *i.e.* it gives a curve which represents the pressure as a function of the time. The arrangement consists essentially of a piston which bears against the centre of a very stiff spring whose upper side is held by two knife-edges, on the end of a strong screw held in a massive frame attached to the gun. The spring is a short piece of steel girder (or a circular plate) and carries on its end a small concave mirror. The latter gives the pressure curve, the light from an arc lamp being sent through a small aperture and focused by a good photographic lens upon a film carried by a rotating drum, after being reflected by the mirror. For maximum pressures the drum is rotated about 1/100 of a turn as the individual exposures are made. The film when developed shows a series of straight lines, the height of which represents the max. pressure in the barrel. When used to give the pressure–time curve, the drum is rotated at a peripheral speed of 30 to 50 m. per sec. From the pressure–time curve the pressure–distance curve may be obtained by integration. From the pressure–time curves much valuable information can be obtained. Curves are reproduced for various powders, and from these it is easy to compare the rapidity and duration of burning, max. pressure, maintenance of pressure, total impulse, the pressure at which the bullet leaves the barrel, and the time in the barrel. In a subsequent paper the theory of the apparatus will be given and the conclusions that may be drawn from it, including the resistance of the barrel and the variation of specific heats.

A. W.

1344. *New Gyro-Compass.* **O. Martienssen.** (Zeits. Instrumentenk. 39. pp. 165–180, June, 1919.)—Describes by aid of many diagrams and photographs the improvements effected in the author's gyro-compass since its first introduction. [See Abs. 22 (1913).] The mathematical theory is also given.

E. H. B.

1345. *Gimbal Stabilisation.* **V. Bush.** (Frank. Inst., J. 188. pp. 199–215, Aug., 1919.)—The paper gives an analysis of the effectiveness of gimbals of various designs for maintaining a horizontal platform on shipboard, and of the gyroscopic stabilising of such devices. The results are shown in graphs and numerical cases are worked out.

E. H. B.

1346. *Critical Load for Strut of Non-Uniform Section.* **K. Aichi.** (Phys.-Math. Soc. Japan, Proc. 1. pp. 174–179, June, 1919.)—Discusses approximate formulæ for the critical load of struts of which the moment of inertia of cross-section varies, according to some definite law, along the strut.

J. W. T. W.

1347. *Impact Tests of Resilience of Steel.* **A. Cornu-Thénard.** (Comptes Rendus, 168. pp. 1315–1318, June 30, 1919.)—A continuation of previous work on this subject [see Abs. 709 (1917)] in which the effect of the velocity of the hammer is determined over a much wider range than before (a ratio of 1 to 10^{-5} between extremes). It is found that for most steels the effect of the velocity of the hammer is inappreciable in the results, but this is not the case for a very soft steel where the ratio of the resilience under sudden and gradual impact may be of the order of 4 to 1.

J. W. T. W.

1348. *Impact Tests of Resilience of Steel.* **A. Cornu-Thénard.** (Comptes Rendus, 169. pp. 272–275, Aug. 11, 1919.)—Describes experiments on soft steel to determine whether variation in the form of the notch has any considerable effect on the results. It is found that for this material the diam. of the notch should not exceed 2 mm., while its depth should be approximately half the thickness of the test-piece.

J. W. T. W.

1349. *On a Probable Mean Value of Grain-size within a Given Circle.* **S. Sano** and **S. Ohashi.** (Phys.-Math. Soc. Japan, Proc. 1. pp. 216–222, July, 1919.)—A mathematical investigation, using the principle of probability, of the mean size of crystals lying within a given circle. This is shown to be $S = \frac{A}{N + n/2}\left\{1 + \frac{kn}{(N + n/2)^{3/2}}\right\}$, where S is the mean size, A the area of the circle, N the number of whole crystals, and n that of the crystals only partly enclosed, and k is a factor dependent on the shape of the grains. k varies from 0·25 to zero, being greatest in the case of circles; values being tabulated. Thus for hexagonal sections $k = 0{\cdot}288$. For all practical purposes Jeffries' formula $S = A/(N + n/2)$ is sufficient. F. C. T.

1350. *Experimental Data obtained on a Charpy Impact Machine.* **F. C. Langenberg.** (Am. Inst. Mining Eng., Bull. No. 152. pp. 1471–1499, Aug., 1919.)—A nickel-chrome steel forging, 5 in. in diam. and 10 ft. long, containing 0·48 % C, 0·64 % Mn, 0·19 % Si, 0·018 % S, 0·03 % P, 3·06 % Ni, and 1·07 % Cr failed in service. It was threaded throughout its length with a square thread ¼ in. deep. The tensile properties as received were:—

	Elastic Limit. Lbs. per sq. in.	Tensile Strength. Lbs. per sq. in.	Elongation. %.	Reduction of Area. %.	Brinell Number.
Longitudinal	104,000	136,500	19·2	51·2	288
Transverse	85,000	119,350	8·8	5·7	280

In the investigation a very large number of impact tests, tensile and bending, were made on the Charpy machine, both unnotched and with a square notch. Miniature forgings were also made for comparison. It was found that the microstructure consisted of martensite, which was supposed to explain the failure. After repeating the heat treatment, but tempering at 650° C. to produce a sorbitic structure, satisfactory results were obtained. F. C. T.

1351. *Use of the Oscillograph for the Study of Ballistic Problems.* **H. L. Curtis** and **R. C. Duncan.** (Phys. Rev. 14. pp. 183–184, Aug., 1919. Abstract of paper read before the Am. Phys. Soc., April, 1919.)—The Bureau of Standards undertook investigations of the possible causes of dispersion of the U.S. Navy's 14-inch guns under actual service conditions. Apparatus was designed (1) to determine the firing time-intervals, (2) to determine the motion of the gun during the firing of single gun salvos and also of turret salvos. The former involved the determination of the time of the occurrence of various events which indicate the completion of certain steps in the progress of the firing. The latter involved the study of the recoil of the gun and also its lateral motion in both vertical and horizontal directions. A description is given of the modifications carried out on the General Electric oscillograph for recording the required measurements. A. W.

1352. *Ellipsoidal Equilibrium Figures for a Liquid in Rotation, and the Variation of the Major Axis.* **A. Véronnet.** (Comptes Rendus, 169. pp. 328–331, Aug. 18, 1919.)—By introducing as parameter the major axis, in place of the density, in the formulæ for ellipsoidal equilibrium figures (see P. Appell, note A, Annuaire du Bureau des Longitudes, 1919), the variation in size of the figures is obtained at the same time as the variation in shape, and the real values of the elements may be calculated in the course of the evolution and contraction of the mass, by assuming the moment of rotation to be constant. The ellipsoids of revolution are given by $g=4\surd(1+l^2)[\{(3+l^2)/l^3\}\tan^{-1}l-3/l^2]=50\mu^3/3f\,M^3a$. From this expression it follows that g is always increasing with l, and conversely that the major axis is always decreasing, but tends towards a finite limit. Applications are made to the rotations of the earth and moon. For ellipsoids with three axes, the formula becomes, $g=(s+t)^2h/(st\sqrt{t})$. At the limit when s tends towards zero, this value tends logarithmically to infinity, and a towards zero, with b and c. The ellipsoid with 3 axes thus tends towards an elongated ellipsoid of revolution, but indefinitely vanishing. The centrifugal force should then be equal to the attraction in the direction of the major axis from the extremity to the centre. Further applications are considered, with illustrative diagrams, of axis variation with contraction or density. H. H. Ho.

1353. *A Generalised Hydraulic Problem. Flow of a Gaseous Mixture during Combustion.* **E. Jouguet.** (Comptes Rendus, 169. pp. 326–328, Aug. 18, 1919.)—This paper, which is entirely mathematical, first contains an expression for the gaseous flow before ignition, and then an investigation of its modification caused by combustion. The flow takes the form of a cone, having the orifice for base, which separates the unburnt portion from that undergoing combustion. The angle at the apex of this cone depends, as Gouy has indicated, upon the ratio between the speed of the flame and that of the fluid molecules. According to the author's conception for deflagrations, the lateral surface of the cone should be considered as a wave of shock and combustion with pressure gradient, from which the formula is deduced giving the diminution in flow, resulting from the fact that the gas is ignited at its exit from the orifice. Unfortunately the expression, which is rather complex, contains the speed of the flame; a quantity which it is necessary to obtain by experiment. H. H. Ho.

1354. *New Method for the Experimental Study of Flat Spirals.* **J. Andrade.** (Comptes Rendus, 168. pp. 1268–1270, June 23, 1919.)—The accurate balances described previously by the author have found numerous applications for all static measurements of natural couples. The author now extends his results by a further experimental study of flat spiral springs. The various forces operating are first considered in detail, and then the necessary experimental arrangements are described for ensuring accurate regulation. By means of this special spiral balance the deviation of the natural axis of oscillation from that of the pivot is prevented, and so the pivot friction is greatly reduced. H. H. Ho.

1355. *Viscosity and its Measurement.* **F. Lawaczeck.** (Zeits. Vereines Deutsch. Ing. 63. pp. 677–682, July 19, 1919.)—After the derivation of the well-known equations for the motion of a viscous fluid, the paper passes on to the description of a new viscosimeter that is equally applicable to liquids and gases, is simple to use, and said to be absolutely accurate. It consists of a glass tube, containing the fluid under test, inside which a metal body slides. The time of fall of this body is proportional to the viscosity of the fluid. The paper is illustrated by a number of diagrams and views of the apparatus described. E. H. B.

1356. *Determination of the Surface Tension of Oils with the Capillary-Plates Apparatus.* **L. Grunmach** and **W. Bein.** (Normal Eichungs-Kommission, Wiss. Abh. 60. p. 1. 1917. Zeits. Instrumentenk. 39. p. 195, June, 1919. Abstract.)—The capillary-plates apparatus consists of two glass plates so mounted that they are in contact along one edge but may make any desired angle with each other. When they are placed vertically and the lower edges just dip below the surface of a liquid, the surface of the liquid takes the form of a rectangular hyperbola. From the coordinates of this hyperbola and the known angle between the plates the surface tension of the liquid can be ascertained. The measurements are made easier by comparison with a glass plate on which a series of confocal hyperbolas, of known coordinates, has been photographed. This is superimposed, with due precautions, on the capillary-plates apparatus, and the angle between the plates of the latter adjusted by means of a micrometer screw until the surface of the liquid between the plates coincides exactly with one of the hyperbolas. The data thus obtained for the surface tension at 18° of eleven oils and of benzene are given. T. S. P.

1357. *On the Theory of the Brownian Movement. Appendix.* **J. D. van der Waals, Jr.** (K. Akad. Amsterdam, Proc. 21. 8. pp. 1057–1061, 1919.)—This paper is a discussion of some objections raised by Ornstein and Burger [Abs. 1144 (1919)] to a theory of the Brownian movement developed by the author in a previous paper [Abs. 12 (1919)]. The latter claims that Ornstein and Burger have misunderstood him in a remarkable way, since when they think to give his views, theories are enunciated in contradiction with his (the author's) meaning; while on the other hand when they believe themselves to be in contradiction, the reasoning advanced is entirely in agreement. The author now claims to have completely refuted Ornstein and Burger's objections. H. H. Ho.

1358. *Stability of A. W. Stewart's Atom.* **L. C. Jackson.** (Phil. Mag. 38. pp. 256–266, Aug., 1919.)—The author here investigates mathematically the conditions for the equilibrium and stability of Stewart's atom [Abs. 11 (1919)] in its simplest form in which all the inner negative electrons are in a single ring, the positive electrons also in a single ring, and the cometary electrons in a single ellipse, which might be expected to be the case for the atoms of simplest structure and lowest atomic weight. The law of inverse squares is assumed, being involved in the presence of elliptic orbits. It is also assumed that the total number of negative electrons is equal to the atomic number, and that the number of cometary or valency electrons is in accordance with the accompanying table :—

Group in Periodic System	0	1	2	3	4	5	6	7	8
No. of Valency Electrons	0	1	2	3	4	5	6	7	—
Valency	0 0	+1 −7	+2 −6	+3 −5	+4 −4	−3 +5	−2 +6	−1 +7	— —

The conditions found are then applied to simple cases which would correspond with the atoms of He, Li, and Be, with the result that equilibrium could not be maintained indefinitely, even in the absence of external perturbing forces; so that instability would be credited to those elements which are found experimentally to be the least unstable. If the positive and negative rings were interchanged, an alternative possibility pointed out by Stewart, the inner ring would still break up, and, moreover, a copious supply of positive electrons would then be given off, an effect not so far observed.

The author hopes to investigate Stewart's further alternatives of a ring of positives and negatives forming a sort of double-star system, as the success of his atom in accounting for chemical phenomena makes it reasonable to hope that, by some such modification, the atom may become more amenable to ordinary dynamics and more successful in accounting for physical phenomena. G. W. de T.

1359. *Reply to the Observations of L. Vegard with respect to Work on the Crystal Lattice and Bohr's Atomic Model.* **M. Born** and **A. Landé.** (Deutsch. Phys. Gesell., Verh. 21. pp. 385–387, June 30, 1919.)—The authors have based their work [see Abs. 527 (1919)] on the crystal lattice and Bohr's atomic model upon Sommerfeld's investigations into the arrangement and motion of electrons in ring systems. They have now to deal with Vegard's claim to priority [Abs. 1279 (1919)]. In Section 1 the authors deal with the hypothesis of the increasing quanta numbers whereby every electron in the innermost ring should have one quantum; every electron in the second ring, 2 quanta, etc. This idea was contained originally in Moseley's formula for Ka and La, published in 1913 and 1914, and the diquantic character of the L orbit was fully confirmed by Sommerfeld in 1916. Vegard's communications are of later date, and supplement Sommerfeld's work by solving the structure of Röntgen spectra. Kossel's work, that the electron was emitted from a primary ring of the atom to its inner ring, appeared in 1914. The authors referred to Sommerfeld's work instead of that of Vegard, because they required the exact ring diameter which they first found in Sommerfeld's paper and not in the somewhat earlier publication of Vegard. At the same time the authors do not deny Vegard's priority with respect to his bold proposals on the distribution of the ring, and the subsequent application to the structure of the periodic system and other physical facts. The assertion of Vegard with respect to the hypothesis of increasing quanta numbers is thus incorrect. The authors have established that the density of the halogen alkali-salts is only correctly given when the first ring is assumed to be monoquantic, and all following to be diquantic. This is in agreement with Sommerfeld's result on the L- term, but in contradiction with Vegard. The authors opine the whole ring structure to be in doubt as a result of their investigations into compressibility. Section 2 deals with the common elliptic state. The authors here agree with Sommerfeld that the ellipse is only a possible arrangement for the electrons but not exclusive. Defects and omissions in Vegard's paper are pointed out. In Section 3 the authors consider the number of electrons in the rings, basing their work on Kossel's ideas with respect to electronic distribution, which appear to them to be better founded on the chemical facts than the results of the Röntgen-ray investigation. Reasons are given for their choice of 2 and 8 electrons in place of the 3 and 7 proposed by Vegard. H. H. Ho.

1360. *Atmospheric Stirring Measured by Precipitation.* **L. F. Richardson.** (Roy. Soc., Proc. 96. pp. 9–18, Aug. 1, 1919.)—Since on the average the water content of the atmosphere is not increasing, the water which descends as precipitation through any horizontal surface must have been stirred up into the atmosphere through that surface. So we can compute the eddy-diffusivity from a knowledge of the mean precipitation and the mean vertical gradient of mass of water per mass of atmosphere. Since the mean values taken in the paper for rainfall, etc., are for the whole globe the eddy-diffusivity obtained must be regarded also as a mean for the whole earth, and in it are included the effect of vertical currents in cyclone and anticyclone, cumulus eddies, and all causes of mixing on both the large and the small scale. The mathematical treatment marks a departure from Taylor's work [see Abs. 586 (1915) and 287 (1918)], since in the latter the air density and stirring coefficient are treated as independent of height, whereas in the present paper a more general treatment is adopted. It is found that the stirring is best measured by the coefficient ξ in the equation $\partial\chi/\partial t = (\partial/\partial p)(\xi \, . \, \partial\chi/\partial p)$, where χ may be either mass of water per unit mass of atmosphere, or entropy per unit mass, or horizontal momentum in a fixed azimuth per unit mass. The variable p (pressure) is here used in preference to h (height). The relation between Taylor's K and Richardson's ξ is given by $K \, . \, \partial^2\chi/\partial^2 h^2 = (\partial/\partial p)(\xi . \partial\chi/\partial p)$.

For determination of ξ the equation $\xi/g^2\rho \, . \, \partial\mu/\partial h =$ (mean rate of precipitation over the globe) is deduced, where $\mu =$ mass of water per mass of atmosphere. From estimates of precipitation and of vertical gradient of mass of water per mass of atmosphere, as means over the whole globe, it is found that ξ has the following mean values :—

Height.	ξ.
8500 metres	8 to 180 cm.$^{-2}$ gm.^{2} sec $^{-5}$
500 „	140,000
0·5 „	Possibly as low as 1000, or even less.

The value at 500 m. is in perfect agreement with Taylor's result deduced from analysis of temperature on the Eiffel tower. The data employed for the determinations at 8500 m. and 0·5 m. are less satisfactory, but the relative smallness of the values of ξ at these heights cannot be accounted for by the lack of precision in the data. It is concluded that ξ at these heights is very materially smaller than at the intermediate height. J. S. Di.

1361. *Atmospheric Pollution from the Engineer's Standpoint.* **J. B. C. Kershaw.** (Engineer, 128. pp. 197–198, Aug. 29, 1919.)—A summary of the fourth Report of the Advisory Committee on Atmospheric Pollution dealing with observations made in the year April 1917–March 1918. Owing to war conditions many of the towns contributing in earlier years were unable to continue observations. The present report contains results from 24 gauges in the following towns: London, Manchester, Glasgow, Newcastle, Leicester, Coatbridge, Rochdale, St. Helens, and Malvern. Comparing with the measurements in 1914–1915 a general increase in solid deposits is recorded. Thus the fall in London (Embankment Gardens) has increased from 598 tons per sq. mile per year to 743, and in Newcastle from 477 to 639. Rochdale now heads the list with 1069 tons, and Malvern Wells represents the other extreme with 80. London (Embankment Gardens) shows the largest deposit of soluble matter; and Newcastle of insoluble matter, 88 tons per sq. mile per month. The separate constituents of the soluble and insoluble matter are set out in tables. Considering the data for different months it is found that in Glasgow insoluble matter shows its maximum in the summer months while soluble has its maximum in the winter. In London there is no sign of such seasonal variation. This difference may be partly accounted for by the fact that two of the three London gauges are on roofs of buildings and therefore

raised above the summer dust from streets. The bearing of the results tabulated on the use of rain water for boiler-feed purposes is pointed out.
J. S. Di.

1362. *Mean Sea-level.* **D'A. W. Thompson.** (Nature, 103. pp. 493-495, Aug. 21, 1919.)—The level of the sea, or more generally, the form of its surface, is the resultant of two kinds of forces after eliminating the effects of the tides. There is the action of sea currents and densities (intrinsic forces); and that of wind and barometric pressure (extrinsic forces). Witting thus summarises the effects of the extrinsic forces: (1) Every barometric distribution of any permanency produces a deformation of the surface of the sea. (2) The ascending slope so produced is not identical in direction with the barometric gradient, but deviates to the right in the Northern Hemisphere. (3) The amount of slope is greater than that which would correspond with the hydrostatic pressure, induced by the barometric distribution. With regard to the intrinsic forces we know enough to choose a point at sea where no movements are caused by the distribution of densities. This is the zero pressure-level. A geodetic surface drawn through this point may be considered the datum level. Proceeding outward from such a point, Witting has calculated the hydrodynamical gradient due to densities, and added to it the effect of barometric pressures. He has found that levels thus calculated for the Baltic area agree to a surprising closeness with the determinations of precise levels.

The question of secular changes of level is beset with difficulties. But assuming the coast from Wismar to Pillau has kept at constant level, Witting mapped the changes in level in the Baltic from 1898 to 1912. Some minor fluctuations are related to seismic phenomena; *e.g.* there was an interruption in the general upheaval at the time of the Scandinavian earthquake, 1904. For some centuries past the elevation of the Fennoscandian lands has gone on at the present rate. The phenomenon has been approximately the same for six thousand years, but during the Bronze Age and just after, it was possibly slower. The more ancient phenomena are difficult to discuss, as a damming up of the Baltic outlet would produce results similar to actual land elevation.
W. A. R.

1363. *Sea Soundings from Propagation of Sound in Water.* **Marti.** (Comptes Rendus, 168. pp. 1100-1102, June 2, 1919.)—A method of ascertaining the depth of the sea from aboard a boat in progress, based on the propagation of sound in the water to the bottom and back. A small explosive charge is fired in the water at the side of the boat; a microphone at a slight depth and at a known distance detects the initial sound and its return after reflection at the bottom of the sea. These two sounds are registered on a chronograph. Thus, the time being known and the mean speed of sound in the water under the conditions of the test, the depth is easily calculated.
E. H. B.

1364. *Greenwich Results of Seven Years' Observations with Cookson Floating Zenith Telescope.* **H. S. Jones.** (Roy. Astron. Soc., M.N. 79. pp. 542-558, June, 1919.)—Photographic observations are made by the Talcott method of pairs of stars of nearly equal zenith-distance north and south in 16 groups of 4 or 5 pairs each, cyclically observed, and arranged in such a way as to give the largest possible aberration factors. Most of the mean zenith-distances are less than 15′, so that they are photographed in the centre of the field of the object glass, the trails being on the meridian are parallel to one another;

hence measurement is simple, with very small corrections for curvature and adjustment errors. The mean of nearly every pair is within 1′ of the zenith, so that corrections for scale-variation are also very small. In the present paper details are given of the determination of scale and its temperature coefficient, of the measurement of the plates, instrumental corrections, refraction, proper motion, etc.

The results are not quite of equal weight, as on thick nights the fainter star trails are missing. The results for latitude variation are quite accordant with those of the International Latitude Service, and for the aberration-constant the value 20·442″ is obtained, leading to a solar parallax of 8·815″. These results are discussed with a view to determining the weight to be attached to them and to find how they may be improved next time. The accuracy of the latitude variation has justified the completion of the Greenwich meridian results without waiting for the International figures. The probable error of the aberration constant is much greater, on account of the shortness of the summer nights which diminishes the aberration factor then, and the comparative scarcity of the winter observations, many of which also are of less weight on account of the failure of the fainter stars. Plates have not been rejected with sufficient freedom. The author considers it desirable to use a larger aperture for the object glass to ensure trails of 7th magnitude being easily photographed. This would greatly increase the range of stars available. The same purpose might be attained without increasing the aperture if a doublet lens were employed instead of a triplet. As only the centre of the field is used this would lose nothing. The various errors are tabulated as follows :—

Error of measurement	± 0·023″
„ the star images	± 0·039
„ the plate	± 0·038
„ the night	± 0·051
resultant	± 0·078

and since about 20 plates are used for each value of latitude variation the probable error of each should be about ± 0·017.″

A further period of seven years is to be undertaken, with a revised list of pairs of stars, omitting the faintest of the old series and also those whose brightness is too great to give a narrow trail, and replacing them with stars of intermediate brightness. W. W. B.

1365. *Periodic Terms in Meridian Circle Results. In Right Ascension.* **R. H. Tucker.** (Lick Observat., Bull. 10. [Circ. No. 323] pp. 47–51, 1919.) —As in preceding abstracts, fundamental observations in 1905 to 1908 show distinct variations in R.A. near sunrise and sunset, similar to those noted at Cordoba by Zimmer [Abs. 401 (1919)]. The results are tabulated, the mean conclusion being that stars are observed relatively later at sunrise than at sunset. A special table is given for *a* Andromedæ which can be observed all the year round on the meridian. The difference of 0·05s. obtained from both sets of observations, twelve-hour groups and *a* Andromedæ, can be divided into halves, one for sunrise and the other for sunset. Parallax is too small to account for them, and precautions taken exclude personal equation and clock variation. The author's suggestion is that there is a sort of horizontal refraction due to the unequal heating of the atmosphere E. and W. of meridian making the layer of air traversed more of the nature of a prism than a plate. The amount is comparable with the variation of refraction at sunrise and sunset, or half the difference between day and night refractions [see Abs. 904 (1917)]. W. W. B.

1366. *Periodic Terms in Meridian Circle Results. In Latitude Variation.* **R. H. Tucker.** (Lick Observat., Bull. 10. [Circ. No. 322] pp. 36–42, 1919.)—In 1917 and 1918 the latitude determinations with Lick meridian circle show a periodic variation. A difference of refraction between day and night previously recognised [see Abs. 904 (1917)] does not come into the present investigation of the variation, the observations being taken almost entirely in the earlier part of the night. Pulkova refractions have been used with uniform correction $-0{\cdot}20''$ tan Z.D. A periodic term depending on R.A. is shown in the tabulation of observations of fundamental stars in hours of R.A., the form of the term being $-0{\cdot}20'' \cos(\alpha - 3^h)$. This may be a seasonal effect depending on the time of year. The circumpolar stars give a similar result, but the upper culminations differ somewhat from the lower culminations. The seconds of latitude are given by fundamental stars as $25{\cdot}29'' - 0{\cdot}18'' \cos t$ and by circumpolar stars as $25{\cdot}48'' - 0{\cdot}20'' \cos t$. Separating the latter the upper culminations give $25{\cdot}49'' - 0{\cdot}26'' \cos t$ and the lower $25{\cdot}47'' - 0{\cdot}14'' \cos t$. In these t is reckoned from the beginning of the year when the mean R.A. of observations is about 3^h. Taking out Chandler's latitude variation the residual becomes $25{\cdot}39'' - 0{\cdot}32'' \cos t$, so that the new periodic term is larger than Chandler's and of the opposite sign. The differences between Auwers' new system and Boss' Preliminary General Catalogue are considered, but they are not large enough to account for the periodic term in the latitude. The mean correction to Auwers, derived from Boss, agrees better with the correction to the mean of the fundamental declinations of the zone (40°) where the difference is greatest, if the correction to the Pulkova refractions is not applied to the Lick observations of Z.D. W. W. B.

1367. *Periodic Terms in Meridian Circle Results. In the Mire and Level.* **R. H. Tucker.** (Lick Observat., Bull. 10. [Circ. No. 322.] pp. 43–46, 1919.)—A persistent periodic term is shown by observations of circumpolar stars in the earlier part of the night of the form $-0{\cdot}060'' \sin \Delta\alpha$, where $\Delta\alpha$ is the difference between the sidereal time at 10 p.m. in any month and that at 10 p.m. on Dec. 1. From 1911 Oct. to 1919 April the variations of level and mire (azimuth mark in meridian) are tabulated monthly, and compared with calculated values according to determinations made from 1898 onwards. The total annual variation in position of the mire is about 0·01 in., and may be due to seasonal effects of the influence of temperature on the south slope of the mountain near the edge of which the pier for the mire is placed. The level correction varies greatly in the year but little from night to night, but the azimuth varies as much daily as annually. W. W. B.

1368. *Origin of Planetary System and Spiral Nebulæ.* **E. Belot.** (Comptes Rendus, 168. pp. 1097–1100, June 2, 1919.)—In continuation of a previous paper [Abs. 400 (1919)] on the hypothesis that a directly rotating planetary nebula coming into collision with an irregular nebulous mass was the origin of our planetary system. The author attributes to such a collision vibrations in the sun's mass alternately swelling it at the equator and the poles, thus periodically throwing off planets from the equatorial mass with diminishing energy, of which the only manifestation now remaining is the sunspot periodic variation. The outer planets being thrown off from outer, less dense layers of the sun are of less density than the inner plants. Analogous phenomena are shown in the early stages of novæ before maximum and in the light-curves of variable stars.

From considerations of radiation-pressure under the assumed primitive conditions he deduces formulæ giving relations between the distances from the sun of consecutive planets of the system, and for the inclination to the ecliptic of their axes. From the study of variation in the direction of the collision he finds that if the collision is nearly normal a planetary system results; if nearly tangential, a spiral nebula. The limiting case of a collision at 45° separates the two possibilities, and it appears from the geometry of the case that the probability of a spiral nebula is $(\sqrt{2}+1)=2{\cdot}414$ times that of a planetary system, thus accounting for the large number of spiral nebulæ.

W. W. B.

1369. *Eruptive Prominence of* 1919, *May* 29. **W. Moss.** (Roy. Astron. Soc., M.N. 79. pp. 553–555, June, 1919.)—A selection is given on the accompanying plate of 12 plates from a series of photographs taken with the Kensington spectroheliograph from the afternoon of May 28 to the morning of May 30, covering the period of the eclipse. These show considerable changes in an eruptive prominence, and the notes add some details shown on the negatives but missing in the reproductions. The most rapid growth noted was about 90,000 miles in less than two hours at noon on May 29, and at the rate of 55,000 miles an hour for ¾ hour later in the afternoon. The max. length of the prominence was about 362,000 miles, and the max. height 150,000 miles.

W. W. B.

1370. *Spectral Peculiarities of Nova Aquilæ III. in July,* 1919. **W. H. Wright.** (Lick Observat., Bull. 10. [Circ. No. 322.] pp. 30–32, 1919.)—In consequence of Barnard's announcement that the nova had developed a nebulous disc [see Abs. 360 (1919)] special attention was directed to its spectrum at Lick Observatory with the Crossley reflector. The disc appearance is strongest in N_1, N_2 and λ4363, and is much more conspicuous in "Seed 23" plates (sensitive to the green) than in ordinary lantern plates. An axis of separation is indicated with position angle 112°. With the slit in this position the bands record as straight with the spectrum. At right angles to this position the peculiarity noted in this paper is a maximum. It is a sinuosity like an elongated S laid horizontally along a straight line ≃, the straight line being due to the continuous spectrum and the thickening to the nebulous matter. The result indicates that the light from the part to the north of the axis of separation is from a redder source, and that to the south of it from a bluer source, but this is reversed in the outer regions at the extreme ends of the bands. The continuous spectrum extends far into the ultra-violet, beyond λ3346 with longer exposure, suggesting a very high temperature.

W. W. B.

1371. *Spectrum of Nova Aquilæ,* 1918, *Aug.* 23 *to Oct.* 23. **A. L. Cortie.** (Roy. Astron. Soc., M.N. 79. pp. 555–561, June, 1919.)—[For previous period see Abs. 275 (1919).] This paper is concerned with four dates only, the intervening ones being Sept. 25 and Oct. 4. The principal concentration of light during the period was about λ5007, H_β, λ4640, H_γ and H_δ, but the relative intensities varied, the $H\gamma$ set being always the brightest. On Oct. 4, λ5007 was visually brightest. The $H\gamma$ group includes not only the triple $H\gamma$ hydrogen radiation but also the nebular line λ4363, and possibly He, λ4388, is responsible for widening the band, which showed a very complicated structure on Aug. 23. A table comparing the spectrum on Aug. 23 with that on Oct. 23, includes 41 lines: nebulium, 7; He, 7;

H, 6; O, 8; and one each of N, Cr, Ti, and Si. The author discusses the differences and the details of the more important bands, especially in the light of the suggestion of the merging of the α Cygni and γ Orionis types [see Abs. 714 (1919)]. He considers that the great relative strength of the chief nebular lines and the pressure of O-type stars proves that after Aug. 23 the spectrum was principally that of a planetary nebula; that the He, O and N lines still showing on Oct. 23 prove the persistence of the γ Orionis type; and that the α Cygni type lasted at least till Oct. 4, and partially till Oct. 23. The H bands have remained of nearly constant width for the whole five months from June 9. W. W. B.

1372. *Form of Green Nebular Bands in Nova Aquilæ III.* **J. H. Moore** and **C. D. Shane.** (Lick Observat., Bull. 10. [Circ. No. 322.] pp. 82–84, 1919.) —In addition to the Crossley reflector [see Abs. 1370 (1919)] a single-prism spectrograph was used on the 36-in. refractor to investigate the small greenish disc of Nova Aquilæ. The results are given in greater detail, but the conclusion is quite in accordance with that arrived at from the reflector observations. The disc is due mainly to N_1 and N_2 bands, the direction of the corresponding discs being 3″ and 2·2″, whereas the H_β disc is only 1″ in diameter. Precautions are described to eliminate error of focus, astigmatism of prism, and drifting of the image, and also to prove that the effect was not due to the presence of plane-polarised light. Actual measures are tabulated of the sinuosity previously described [*loc. cit.*]. W. W. B.

1373. *Nova Aquilæ.* **H. Thomson.** (Brit. Astron. Assoc., J. May, 1919. Nature, 103. p. 353, July 3, 1919, Abstract.)—Comparisons with B.D. + 0°·4027 (mag. 6·04) give the magnitude of Nova Aquilæ, March 28, 6·14; April 26, 6·14; May 22, 6·37; and May 26, 6·04, a slow decline with fluctuations. The visual spectrum is like that of Nova Geminorum II at a similar stage. The nebular line λ5007 is intense, and other bright lines or bands are still visible with continuous spectrum, practically from D to $H\gamma$. W. W. B.

1374. *Photographic Stellar Parallaxes obtained with 60-inch Mt. Wilson Reflector.* **A. van Maanen.** (Astron. J. 32. [No. 755] pp. 86–88, July 30, 1919.)—About 50 parallaxes of stars, including a few nebulæ, have been obtained from an average of 16 exposures and 8 comparison stars for each parallax, the mean probable error being given as 0·0055″. One of the stars has the proper motion of 3·01″ annually, though only of the 12th magnitude; and another, between 9th and 10th magnitude, is Barnard's P.M. star with 10·3″ annually. The corresponding parallaxes are about $\frac{1}{4}''$ and $\frac{1}{3}''$ respectively. One other star has a parallax of $\frac{1}{10}''$, and for this Porter's P.M. is $1\frac{1}{4}''$ per annum. W. W. B.

1375. *On the Light-Curves of Long-Period Variables.* **J. G. Hagen.** (Roy. Astron. Soc., M.N. 79. pp. 572–574, June, 1919.)—The author compares Pickering's classification into five groups with Phillips' two classes. He finds that of 67 cases, only 4 each belong to two of Pickering's groups and prefers to regard them as exceptions. Of the three remaining groups one corresponds to one of Phillips', and the author finds justification for sub-dividing Phillips' other class to agree with the other two of Pickering's. Turner's classification is also compared, and it is hoped with increased accuracy and numbers of light-curves to obtain a closer connection between the different classifications and find a geometrical interpretation "for the peculiar behaviour of the phase-angles in the harmonic analysis." W. W. B.

1376. *Star-Discs.* **A. E. Conrady.** (Roy. Astron. Soc., M.N. 79. pp. 575–593, June, 1919.)—The author has proposed to obtain accurate information as to the effect on the focal image of a star of the various defects which cannot be altogether avoided: want of focus, spherical aberration, coma, etc. Airy, in 1834, ignored them and dealt only with an ideal image, and Rayleigh, who took into account coma, spherical aberration, and astigmatism, only determined the limit of allowable divergence (¼ wave-length), from spherical waves. The present author deals only with circular apertures, integrating for each infinitely narrow concentric zone, and summing them in 17 concentric sets.

If the focus is ¼ wave-length out, he finds the light intensity reduced to 81 %, but without alteration of diameter of disc or of distribution of light; but as there is diffused light between this and the first ring amounting to 3%, there is a further loss of contrast. With focus ½ wave-length out, the central intensity is only 0·405, and the penumbra much brighter relatively than in the first case, but still the central disc is almost unaltered except in brightness and contrast. Even faint stars show a decided halo in this case. This step in the investigation explains why it is possible to obtain fairly good images of stars in spite of the impossibility of bringing all colours to the same focus owing to the secondary spectrum. The author shows that to keep all the light between C and F within ¼ wave-length of the same focus involves a relation $F = 2{\cdot}8\,A^2$ between Focal length and Aperture (both in inches), so that most large telescopes are too short to reach this ideal; but a reason is given in the paper which accounts for their not being valueless.

Turning to spherical aberration, the author considers the marginal and paraxial images, the "best focus" image coming half-way between them. One-quarter wave-length of primary spherical aberration has no effect large enough for detection, and by adjusting the focus Airy's ideal disc can practically be obtained so far as spherical aberration is concerned. The higher spherical aberration is next considered, and it is found that the amounts which may be left uncorrected without passing Rayleigh's limit increase steadily with the order. Thus the ¼λ of the r^2 term (want of focus), becomes 1λ for the ordinary spherical aberration of r^4, 4λ for the r^6, and 8·5λ for the r^8 term. There still remains, however, the loss of contrast so that a lower limit than ¼λ should be obtained if possible.

Passing on to coma, the author finds the geometrical result quite different from the actual, and that unless the coma is very heavy the image does not suffer very much though the rings are more and more distorted with increasing coma. W. W. B.

1377. *Astrographic Catalogue Magnitude Scales, 14th Note; Tacubaya* (—16°) *and Cape* (—48°) *Magnitudes.* **H. H. Turner.** (Roy. Astron. Soc., M.N. 79. pp. 565–571, June, 1919.)—The author from these two recently published zones obtains further evidence from the Southern Hemisphere for his investigation of the question of the uniformity of scale of magnitude in the different zones [see Abs. 268 (1919)]. He emphasises the importance of establishing this before completing the whole of the international programme. On the provisional assumption that whatever the difference between different observatories, each has its own scale quite consistent, the test can easily be made by comparing sample photographs of the same region; *e.g.* that of the pole. If this assumption is not justified, the author suggests a preliminary count to test the point at each observatory. He then tabulates the figures from the two zones (also comparing Cape zones — 42° and — 43°), and harmonically analyses the residuals. Some of the discordances pointed out lead him to suggest the possibility of a real difference between photographs of the same region taken at northern and southern observatories, and he asks definitely for Hyderabad duplicates of Santiago plates now being measured at Oxford for zone — 22°. W. W. B.

1378. *Stellar Parallaxes Measured at Dearborn Observatory.* **P. Fox.** (Comptes Rendus, 168. pp. 1095–1096, June 2, 1919.)—The series began in the autumn of 1918, but after 2000 plates had been obtained, the entry of America into the war, in the opening of 1917, put a stop to the work. Measurement of the plates was continued, and the present is a list of 85 parallaxes, including the large one of Barnard's Proper-Motion Star, of which two determinations are given, one from 8 plates $+0{\cdot}555'' \pm 0{\cdot}017''$, and the other from 10 plates $+0{\cdot}557'' \pm 0{\cdot}016''$. W. W. B.

1379. *Faint Distant Companion to B.D. + 7°·2690.* **R. Trumpler.** (Astron. J. 32 [No. 756.] pp. 95–96, Aug. 11, 1919.)—While determining the parallax of this star by comparison with neighbouring faint stars, an anomalous result caused the author to suspect one of the comparison stars, and further examination of the plates shows that B.D. + 7°·2692 shares the motion of the principal star which is of 6th magnitude. The angular distance between the stars is about 8′, corresponding to a projected linear distance of 18,200 astr. units or 0·064 parsecs. Adopting a mean of the spectroscopic and trigonometrical parallax determinations, the absolute magnitudes of the stars are given as $+4{\cdot}2$ and $+8{\cdot}0$. W. W. B.

1380. *Distribution of Absolute Magnitudes in and about the Milky Way.* **W. J. A. Schouten.** (K. Akad. Amsterdam, Proc. 21. 6 and 7. pp. 870–880, 1919.)—The author has given [see Abs. 559 (1918)] the results of a determination by Kapteyn's method of the luminosity curve for the whole sky, and for different zones of galactic latitude. In the present paper the same data are treated by Schwartzschild's method. The results differ very much from those obtained by Schwartzschild himself, and suggestions are made as to the cause of this disagreement. Since the author's results by the two methods agree much better, he considers that Schwartzschild's result is in error, and that on the whole Kapteyn's method is preferable. A plate is given showing the results of several investigators, and offering marked differences. W. W. B.

1381. *Observations of Stars from Northern A.G. Zone of Harvard College Observatory.* **R. H. Tucker.** (Lick Observat. Bull. 10. [Circ. No. 321.] pp. 22–29, 1919.)—1070 stars from the Northern A.G. Harvard Zone was selected by F. Schlesinger to serve as standards for the zone photographs taken at Allegheny Observatory. The Harvard observations were taken between 1870 and 1884, with a gap between 1879 and 1883, and though the probable errors were not greater than the A.G. standard, $\pm 0{\cdot}6''$ in each element were considered sufficiently accurate for photographic determinations, besides the drawback of difference of epoch, involving proper motions of some of the stars. Observing was begun in Feb., 1917, and completed in twelve months; two observations being taken of each star, supplying more than twenty standard stars for each

Allegheny zone plate; and the probable errors are given as 0·011^s and 0·11″ in R.A. and Declination respectively. A table is given comparing for each hour the Lick and Harvard places, magnitude equation being applied to the author's observations.

82 new proper motions are computed, of which 28 are at least 0·1″ in one or both elements, and 38 at least 0·1″ in both combined: 25 proper motions are adopted from the Harvard list and 6 from Cincinnati. One pair with large P.M. (1·7″) is not used as a standard, but has been observed. A discussion is given of the probable errors of the observations taken in pairs, and of the effect of observing conditions which were generally good.

74 Harvard provisional proper motions are not confirmed, while 29 are confirmed: a list is given of corrections to Harvard catalogue, and a few interesting stars are noted. W. W. B.

1382. *Distribution of Hydrogen and Nebulium in Orion Nebula.* **J. H. Reynolds.** (Roy. Astron. Soc., M. N. 79. pp. 561–564, June, 1919.)—The use of an æsculin screen enables more details to be shown in the green, and the author has studied the distribution of H and Nu in this way, discussing also the previous work of Keeler and Hartmann with different screens. The Nu appears to be confined to the Huyghenian region, and H$_\alpha$ is very faint except in that region, though the other H-radiations extend much further. W. W. B.

1383. *Distance and Distribution of* 70 *Open Clusters.* **H. Shapley.** (Nat. Acad. Sci., Proc. 5. pp. 344–351, Aug., 1919.)—This is the ninth paper in the author's series of studies of magnitudes in star clusters, and deals with the question of the apparent scarcity of globular clusters near the plane of the Milky Way. It has been suggested that such clusters on approaching the galactic concentration may be compelled to widen out into open clusters, so that the point of the present investigation is to test the reality of the above-mentioned scarcity, and also to see whether the distribution of open clusters lends any support to the hypothesis that they have developed from globular clusters. If the absence of globular clusters is not real, there must be some form of obscuration present, in which case some of the conclusions reached in previous years must be modified: the distance of the centre and the dimensions of the galaxy would probably be greatly increased, and the suggested transition from globular to open clusters is perhaps not at all rapid, possibly not even inevitable. The data for the present discussion include (1) 30 spectrograms of about 200 faint stars made with slitless spectrograph at the 80-ft. focus of the 60-in. reflector, (2) more than 100 direct photographs at the primary focus of the 60-in., (3) magnitudes and colours of about 2000 stars, and (4) the measurements of diameter and form of all known clusters on Franklin-Adams charts, Harvard photographs, or Mt. Wilson plates. The largest parallaxes are uncertain on account of the uncertainty of the relation between parallax and diameter on which the investigation depends, the correlation curve being naturally indefinite at the end, and the very small ones are equally uncertain on account of the relative largeness of the error of measurements, etc.

The concentration about the galaxy is clearly shown. The mean distance of the 70 clusters in the plane is 5900 parsecs, all values (omitting the Pleiades) being between 400 and 16,000 parsecs. The author infers that the open clusters are intermingled with the non-cluster stars. The same segment of longitude that has so few globular clusters in low latitude is also scantily provided with open clusters, which is not in favour of the evolution hypothesis. Barnard's catalogue of dark markings gives very little evidence of any such obscuration as the alternative theory requires, but Barnard's nebulæ, by showing what seems to be obscuration in small local clusters, point to the probability of the same sort of thing on a large scale in the galaxy, though there is little suggestion of this except in the Magellanic clouds.

The author gives several arguments on both sides, but is inclined to the belief that there is a real obscuration. W. W. B.

1384. *Simplification of Luizet's Method to obtain the Orbit of a Cepheid Variable from its Light-curve.* **F. Henroteau.** (Astron. J. 32. pp. 57–58, June 11, 1919.)—Transforming the light-curve into a curve of relative brightness, and tracing the latter on semi-transparent paper, the curves are superposed after one has been turned over on its mean axis and displaced along it through half a period. The curves will then in general intersect in four points including those of periastron and apastron, of which the former is the one when light-changes are quickest. The abscissæ of these points are the same as for the radial velocity curve, and the eccentricity and longitude of periastron can be obtained from a table constructed at Allegheny. As a sample δ Cephei treated in this way gives elements in good accord with Bélopolsky's. W. W. B.

LIGHT.

1385. *A Fluorimeter.* **A. Muguet.** (Comptes Rendus, 169. p. 59, July 15, 1919.)—The comparison and measurement of fluorescence in connection with radio-active substances have been carried out best by observing the fluorescence through absorbent screens. The fluorimeter here described is based on this principle. The absorbent screen is composed of a regulator formed of superposed sheets of tracing paper which increase from cm. to cm. The substances to be measured are compared with a standard of luminescence obtained by 1 mgm. of radium element, spread on a surface 1 cm.^{2} in area, acting on a platinocyanide screen glued on a bristol board for eliminating the α-radiation. The part of the regulator, *i.e.* the number of sheets of tracing paper needed completely to veil the standard, is represented by 100 and then, from the thickness of tracing paper required to veil each of the specimens, the value of their fluorescence can be deduced.

This arrangement, suitably modified, can be used to measure the X-rays. A. E. G.

1386. *New Artificial Horizon for Sextants.* **L. Becker.** (Roy. Astron. Soc., M.N. 79. pp. 598–604, June, 1919.)—The author maintains that the old artificial horizon used with the sextant gives more accurate results for altitude than any of the modern devices. But he considers that the drawbacks inseparable from the old arrangement may be eliminated by his new suggestion. These drawbacks are: The impossibility of using the old artificial horizon for low altitudes or for altitudes greater than 60°, and, of less importance, the varying inclination of the line of sight.

The principle of the new plan is the use of two plane mirrors relatively fixed, between the object and the gravity-controlled mirror. One of these is chosen to be the index glass of the sextant. He gives diagrams of the path of rays to the sextant-image and auxiliary-image, and the theory of the instrument thus modified is discussed, including the effect of turning the plane of the sextant, and of the observer's turning in azimuth, in which case the auxiliary image describes a curve round the sextant-image; the adjustment of sextant and mirrors, and the determination of index errors. The method of observing is given in detail with a plate showing photographs of two positions of the instrument, mounted for preference on a camera tripod-stand. The error of observation appears to be of the order of one minute of arc, but precautions are necessary on board ship to eliminate the horizontal acceleration. W. W. B.

1387. *Marine Camouflage.* **E. L. Warner.** (Am. Illum. Eng. Soc., Trans. 14. pp. 215–219, July, 1919.)—The object of marine camouflage is not invisibility but course distortion, and the paper describes, and shows by photographs, the degree to which it is possible, by suitable camouflage design, to render the apparent course of a vessel uncertain or actually misleading to an observer. J. W. T. W.

1388. *Camouflage.* **H. van Buskirk.** (Am. Illum. Eng. Soc., Trans. 14. pp. 225–233, July, 1919.)—Describes the method adopted in America for the design and testing of camouflage schemes for ships, to produce course distortion. A model vessel was built and a design tried with the aid of a submarine periscope looking over a false sea towards changeable sky backgrounds, which were operated from the periscope. On the sea, at a distance representing 1¼ miles, was a turn-table which was also operated from the periscope. In this way the model placed on the turn-table could be observed from the periscope at various angles with varying sky backgrounds and lighting conditions. In order to obtain the veiling glare such as exists at sea due to fog, mist, smoke, etc., a movable semi-transparent mirror was mounted between the observer and the model to reflect scattered light into the eye of the observer in a way analogous to the conditions existing in nature. Photographs of the apparatus are given in the paper. J. W. T. W.

1389. *Resolving Power of a Kinematograph.* **A. Klughardt.** (Zeits. Instrumentenk. 39. pp. 146–153, May, 1919.)—A mathematical discussion of the best relation between exposure and obscuration of the picture in a kinematograph showing a subject of any given speed of action. J. W. T. W.

1390. *Theory of the Polarisation Prism.* **H. Schulz.** (Zeits. Instrumentenk. 39. pp. 154–157, May, 1919.)—In continuation of previous work [see Abs. 928 (1918)] the author finds the conditions to be fulfilled for the attainment of achromatism in a polarisation prism. J. W. T. W.

1391. *Positions for Minima of Regular Reflection.* **F. Jentzsch-Gräfe.** (Deutsch. Phys. Gesell., Verh. 21. pp. 361–368, June 30, 1919.)—A theoretical paper in which is calculated the fractional intensity of the light reflected as a function of the refractive index and angle of incidence, both for polarisation in and perpendicular to the plane of incidence. Graphs are plotted for the light reflected from flint glass ($n=1{\cdot}70$) and for electric waves reflected from water ($n=8{\cdot}964$). E. H. B.

1392. *Ostwald's Colorimetry.* **O. Meissner.** (Phys. Zeits. 20. pp. 344–346, Aug. 1, 1919.)—Strictly speaking Ostwald's colorimetry [see Abs. 720 and 1030 (1919)] applies only to "ideally-rough" bodies consisting of elementary mirrors. Albedo may be expressed by $(100-s)$, when $r+w+s$ (tone + purity + blackness) $=100$. In comparing the brightness of different colours, *e.g.* a red surface, characterised by $c_1w_1s_1$, and a blue one, characterised by $c_2w_2s_2$, s_1 should be equal to s_2 for equal brightness. The author further comments on colour-blindness and Goethe's colour theory. H. B.

1393. *Sensitiveness of Photographic Plates to X-Rays.* **N. C. B. Allen** and **T. H. Laby.** (Roy. Soc. Victoria, Proc. 31. pp. 421–430, May, 1919.)—This work was undertaken in order to determine the relation existing between the exposure and the resulting optical density of a plate exposed to X-radiation, and the type of plate most suitable for radiographic work. Work had previously been done by Salomonson and by Hodgson, on the relation between exposure and density. The plates under investigation were given a known exposure, developed in a standard manner, and their densities were measured by a polarisation photometer. For generating the X-rays a Coolidge tube excited by an induction coil was used, the potential across the tube being regulated by adjusting the length of the alternative spark-gap of the coil until a spark passed occasionally. It is assumed that the exposure is proportional jointly to the energy of the X-radiation and to the time of exposure. The exposure in radiography is defined as "energy of incident X-rays per cm^2." It is found that within a limited range of exposure the density of the developed "image" produced in a silver emulsion is proportional to the logarithm of the exposure. The density of the image produced by a given quantity of incident-energy is independent of the wave-length of the radiations used in these experiments. The inertia, contrast, and fog density of a number of plates for low radiation intensities is stated. The speed, *i.e.* the exposure required to produce a given density of a plate, depends on the nature of the emulsion, and the mass of silver per unit plate area. Contrast depends on the nature of the emulsion, and is apparently independent of the mass of silver per unit area. Further experiments are in progress. A. E. G.

1394. *Dispersion of Air and the Reduction of Wave-lengths to Vacuum.* **R. T. Birge.** (Astrophys. J. 50. pp. 72–76, July, 1919.)—Various considerations point to the necessity of having a single method for the reduction of wave-lengths to vacuum. The present paper suggests such a method. The table of corrections to vacuum prepared by the author is now unnecessary in view of the complete treatment of the whole subject by the Bureau of Standards. The Bureau article gives a synopsis of all previous work, and also an extensive table of corrections, which should be used in all future work when the wave-lengths are measured in I. Å. [see Abs. 282 (1919)]. A. W.

1395. *Relation between Rotatory and Dispersive Powers.* **J. Boussinesq.** (Comptes Rendus, 169. pp. 109–114, July 21, 1919.)—Corvallo found experimentally that for quartz the rotatory power is approximately proportional to the expression $k^2(N^2 - \text{const.})$, where $2\pi/k$ is the period of vibration of the radiation considered, and N is the index of refraction. The author has previously given a theoretical derivation of the relation. The present paper gives a fuller treatment, a third approximation being considered. It is shown that apart from the factor k^2, inversely proportional to the square of the period, the rotatory power is an explicit function only of the index of refraction N, and consequently, of the dispersive power. A. W.

1396. *Stark-effect for Metals.* **T. Takamine.** (Mt. Wilson Solar Observat., Contrib. No. 169. Astrophys. J. 50. pp. 23–41, July, 1919.)—The apparatus and methods used were essentially the same as employed by Anderson [Abs. 1358 (1917)], excepting a slight modification in the construction of the kathode and the grating spectrograph. The spectra of the ten metals Ag, Au, Co, Cu, Fe, Mg, Mn, Mo, Ni, and W were examined. Of these, no affected lines were observed in the spectra of Mn and W. In the course of the experiments a few lines of Na, N, and O were also found to be affected by an electric field. The spectra of Co, Fe, Mn, Mo, and Ni were fairly rich in affected lines, while the rest of the metals showed a rather small number of lines affected by an electric field. The colour of the glow in the Crookes dark space was a very bright green in the case of Ag, Cu, and Mg; fairly bright for Fe and Ni; and yellowish for Au, Co, Na, and Mo. The Stark-effect for Ag lines is remarkably similar to that for helium lines. The only difference observed is that in the case of helium all the detached components appear invariably on the violet side, while with silver they usually appear on the red side. Only three affected lines of gold were observed. The Stark-effect for copper is in many respects similar to that for silver. An interesting feature of the present investigation is that there seems to be an unmistakeable connection between the Stark-effect and the pole effect. Tables are given of all results, with typical photographs.

In general, the relation of the Stark-effect to series laws seems to be less simple than that of the Zeeman-effect. An extension of the study of the Stark-effect to the ultra-violet region is much needed. A. W.

1397. *Precision Measurements of X-Ray Spectra.* **M. Siegbahn.** (Phil. Mag. 37. pp. 601–612, June, 1919. Ann. d. Physik, 59. 1. pp. 56–72, June 18, 1919.)—The author describes a method by which accurate measurements can be made of the wave-lengths of lines in X-ray spectra. The results of the investigation, which extends over the longer wave-lengths (greater than 1Å.U.), show that the new values have about a hundred-fold accuracy compared with the older values. The lattice constants of calcite and potassium ferrocyanide were accurately determined in terms of that of rock salt.

Crystal.	*Lattice Constant* (*d*).
Rock Salt.	$2{\cdot}81400 \times 10^{-8}$ cm.
Calcite.	$3029{\cdot}04 \times 10^{-11}$ cm.
Potassium Ferrocyanide	$8{\cdot}408 \times 10^{-8}$ cm.

The following table gives the wave-lengths of the K group for the elements Cl to Cu.

	N.	$\lambda \times 10^{11}$ cm.	
		$K\alpha_1$.	$K\beta_1$.
Cl	17	4718·70	—
K	19	3733·86	3447·37
Ca	20	3351·86	3087·89
Sc	21	3025·26	2774·54
Cr	24	2285·17	2081·44
Fe	26	1932·39	1753·97
Co	27	1785·24	1617·58
Ni	28	1654·67	—
Cu	29	1537·36	1389·53

The rest of the paper deals with the application of the above values of the wave-lengths of the K-series radiation to the atomic theories of Sommerfeld, Debye, and Kroo. The author points out that by increasing the precision of the measurements there seems a possibility of obtaining at least a qualitative conception of the disturbances in the atom planetary system.

E. A. O.

1398. *A Modification of the Fluorometric Method of Measuring the Intensity of X-Rays, and its Application to the Measurement of the Radiation from the Coolidge Tube.* **R. Biquard.** (Comptes Rendus, 168. pp. 851–854, April 28, 1919.)—The fluorometric method of measuring intensity of X-rays consists in measuring the luminosity of a thin screen of barium platinocyanide when exposed to rays falling normally upon it. The fraction of the incident energy absorbed by the screen varies greatly according to the nature of the rays, so that the luminosity is not an accurate indication of the energy of the incident beam. The author has modified the procedure by inserting a sufficient number of thin screens in the beam to absorb all the rays, and obtaining the total luminosity by measuring that of each of the screens in turn in reference to a standard. The following results were obtained with a Coolidge tube over the range of potential from 28,000 to 88,000 volts. (1) The luminosity L of a thin screen exposed to radiation at normal incidence and partially absorbing it, is a function of the square of the mean voltage on the tube; *i.e.*, $L=a(V_m^2-A)$, where a and A are constants. (2) The sum of the luminosities of successive screens sufficient in number to absorb all the radiation varies as the cube of the mean voltage on the tube; *i.e.* $\Sigma L=bV_m^3$. If it be assumed that ΣL is proportional to the energy of the incident radiation, then within the limits of voltage specified, $E=\Sigma L=KV_m^3$ which corroborates the result deduced by Weeks [Abs. 164 (1918)] from calorimetric measurements of the output of a Coolidge tube.

The same laws, as above stated, were also obtained with screens of cadmium tungstate. E. A. O.

1399. *X-Ray Spectra of the Elements.* **M. de Broglie.** (Comptes Rendus, 169. pp. 134–136, July 21, 1919.)—The author has obtained the X-ray spectrum (K series) of rhodium and the absorption spectrum of the L series of radium. From his measurements of the wave-lengths of the fine sharp lines in these spectra he shows that Paschen's law, relating to the fundamental interval of frequency in the case of "luminous" wave-lengths, is also applicable in the case of X-rays. Thus Paschen gives $\Delta\nu_H=0{\cdot}3645$ ($\pm{\cdot}0045$) for the lines in the spectra of hydrogen and helium, whilst the author now obtains $\Delta\nu_H=0{\cdot}369$ for the lines in the K-series X-ray spectrum of rhodium. A. B. W.

1400. *Total Reflection of X-Rays.* **B. Walter.** (Deutsch. Phys. Gesell., Verh. 21. pp. 347–348, June 30, 1919.)—With reference to certain bands observed by Kohler (Fortschr. a. d. Geb. d. Röntgenstrahlung, 24. p. 236, 1916) when X-rays are reflected from a surface under certain conditions, Einstein offered the suggestion that these bands were due to total reflection of the X-rays.

The author now offers another explanation of these bands, without introducing the conception of total reflection of X-rays. A. B. W.

1401. *Crystallographic Measurements by means of X-Rays.* **F. Canac.** (Le Radium, 11. pp. 225–230, June, 1919.)—By turning a crystal through certain definite angles, and obtaining a Laue diffraction pattern in each case, the author deduces the crystal structure. Two methods are described, and excellent photographic reproductions are shown in illustration. A. B. W.

RADIO-ACTIVITY.

1402. *Secondary Radiation Produced by X-Rays.* **B. Bianu.** (Le Radium, 11. pp. 230–234, June, 1919.)—After reviewing the work of earlier observers of this phenomenon, the author describes a novel method of separating the ionisation effects directly due to the α-rays from that due to the secondary radiation. As a result of his experiments the author concludes that a very small fraction of the α-particles are "reflected" when they strike a surface, being accompanied by a secondary radiation, which he calls β-radiation, of which the velocity is 3×10^9 cm./sec.

Substituting the value in the relation $\frac{1}{2}mv^2 = eV$, the corresponding voltage $V = 2400$ volts is determined.

In addition to these rays, it is shown that there exists another electronic radiation of low velocity, this being more complex in nature (comprising electrons of different velocities). An Al foil 0·5μ thick is sufficient to absorb this soft radiation completely, whence it is concluded that the depth of the layer in which it is created is less than 0·5μ. Under these circumstances it is not surprising that the radiation appears heterogeneous; in reality it is quite conceivable that it is homogeneous radiation produced at varying depths in the surface bombarded by the α-particles. The number of such slow electrons is about 40 times the number of electrons comprising the β-radiation, and about 10 times the number of α-particles which strike the surface. A. B. W.

1403. *The Radio-Elements and their Classification.* **Mme. Curie.** (Le Radium, 11. pp. 236–246, June, 1919.)—A general review of the subject, particular attention being paid to the arrangement of the radio-elements in the periodic table. Several interesting tables are included. The paper does not permit of a short extract. A. B. W.

1404. *Relation between Uranium and Radium.* VII. **F. Soddy.** (Phil. Mag. 38. pp. 483–488, Oct., 1919.)—During the current year the author has carried out two sets of measurements on the quantity of radium in certain uranium preparations purified in 1905 to 1909. The results of these measurements completely confirm those of the author and Miss Hitchins in 1915 [Abs. 1425 (1915)]. The measurements show that the growth of radium in uranium purified initially from Io and Ra proceeds regularly according to the square of the time with the period 237,500,000 years as the product of the periods of average life of ionium and radium. This value is stated to be accurate within 5 %, the period of radium scarcely being known to this degree of accuracy. Assuming the period of average life of radium to be 2375 years, that of ionium is 100,000 years. It is not expected that the further growth of radium from these uranium preparations will enable the period of ionium to be determined with much greater certainty. A. B. W.

1405. *Nature of γ-Rays.* **A. F. Kovarik.** (Phys. Rev. 14. pp. 179–180, Aug., 1919. Abstract of paper read before the Am. Phys. Soc., April, 1919.)—A number of experiments have been made to discover whether or not the effects of γ-rays from the same source take place simultaneously in all directions at the same distance from the source. The method employed in the investigation is that of auto-registration of γ-ray effects described in a previous paper by the author [see Abs. 911 (1919)]. It was found that the effects do *not* occur simultaneously, although the average number over a certain length of time is the same for the positions at equal distance from the source. The author offers tentative explanations of these results on the ether-string hypothesis of γ-ray pulses. On the wave theory there seem to be greater difficulties.

Experiments are also described in which is examined the effect of the materials of which the "discharge chamber" is made on the natural effect and on that produced by the γ-rays. The results in this case indicate that while the material of the chamber is of some importance, it is of smaller importance than air in the chamber. A. B. W.

HEAT.

1406. *Influence of the Different Modifications of Sulphur on its Melting-point.* **E. Beckmann, R. Paul, and O. Liesche.** (Zeits. Anorg. Chem. 103. pp. 189–206, June 21, 1918.)—Freshly-fused sulphur, recrystallised from carbon disulphide, solidifies between 119° and 118°. When the sulphur is kept above that temperature for some time, the solidification point sinks slowly down to 114·5° ; at the same time the sulphur turns partly insoluble in CS_2, and this portion is said to make up 3·5 % of the sulphur (Smith and Holmes, 1903). Equilibrium is also assumed to exist between normal S_λ (soluble in CS_2) and abnormal insoluble amorphous S_μ. According to the authors and Aten, S_μ has no influence, because it decomposes into S_λ and S_π. The real natural freezing-point of S_λ is 119·25° ; it is depressed, however, by the presence of $S_\pi = S_4 = 128$, so that the apparent solidification point is 114·5° ; the amount of this S_4 pt is 2·78 %. H. B.

1407. *The Standardisation of the Sulphur Boiling-point.* **E. F. Mueller and H. A. Burgess.** (Am. Chem. Soc., J. 41. pp. 745–763, May, 1919.)—The importance of the sulphur boiling-point as defining a standard temperature requires that the influence of experimental conditions upon the results should be known. In the present investigation the following points were investigated : I. *Type of boiling-point apparatus.*—The influence of the type of apparatus upon the observed temperature was found to be small. With standard forms of thermometers, it is advisable to use tubes not less than 4 cm. in diam. to contain the boiling sulphur and to provide some thermal insulation around the tube. II. *Comparison of radiation shields.*—It was found that the best type of shield is a simple sheet-iron cylinder from 1·5 to 2·5 cm. larger in diam. than the thermometer, and about 4 cm. or more longer than the coil, open below and with an umbrella above. This umbrella should fit the thermometer tube closely and extend beyond the edge of the cylinder, leaving the space 5 mm. to 1 cm. high between the umbrella and cylinder for circulation of the vapour. Data obtained with Al shields, with bright inside surfaces, show that the temperature attained by a thermometer enclosed in such a shield depends upon the form of the shield, primarily upon the extent to which the shield forms a complete enclosure ; upon the extent to which the interior of the shield has become dull or blackened, and also upon the material (transparency) of the protecting tube of the thermometer. The readings obtained range from 0·2 deg. low, obtained with a single cone on a glass enclosed thermometer to 0·02 deg. low, obtained with a nearly closed shield on a porcelain enclosed thermometer. The extreme lowerings found were 0·2 deg. for a glass enclosed thermometer and 0·1 deg. for a porcelain enclosed thermometer. III. *Purity of the sulphur.*—The effect of adding small quantities of As and Se was ascertained. 0·1 % of As raised the boiling-point by 0·02 deg., while 0·1 % Se (plus the 0·1 % As) raised the boiling-point by 0·09 deg. Hence selenium, even in small amounts, would be objectionable. All previous experiences indicate, however, that such impurities are not likely to be found in purified sulphur. A sample of crude sulphur gave a boiling-point not over 0·01 deg. higher than purified sulphur. IV. *Relation between vapour pressure of sulphur* *and temperature.*—The change of vapour pressure with temperature, over the range of pressure from 700 to 800 mm., was redetermined, and is represented by the formula : $t = 444{\cdot}60 + 0{\cdot}0910(p - 760) - 0{\cdot}000049(p - 760)^2$.

E. G.

1408. *Pressure Variations of Specific Heat of Liquids.* **C. Barus.** (Nat. Acad. Sci., Proc. 5. pp. 340–344, Aug., 1919.)—Describes a method by which the interferometer could be applied to the determination of the temperature increment $d\theta$ in the thermodynamic relation $d\theta/dp = \alpha'\theta/J\rho c$, where θ, p, ρ, c, and α' represent respectively the absolute temperature, pressure, density, specific heat at constant pressure, and coefficient of expansion of a liquid.

J. W. T. W.

1409. *Heat-Content of Moist Air.* **W. Schüle.** (Zeits. Vereines Deutsch. Ing. 63. pp. 682–684, July 19, 1919.)—The diagram of the heat-content of moist air due to Reyscher is corrected and extended to 350°. E. H. B.

1410. *Propagation of Flame in Mixtures of Acetylene and Air.* **W. Mason** and **R. V. Wheeler.** (Chem. Soc. Trans. 115. pp. 578–587, June, 1919.)—Haward and Sastry [Abs. 1288 (1917)] found a max. propagation speed of the uniform movement of 260 cm. per sec. in tubes 12 mm. in diam. ; in larger tubes higher speeds would be expected, but le Chatelier's value of 600 cm. for tubes of 40 mm. looked excessive. The authors experimented with tubes of 12·5, 25, 50, 90 mm. diam., making the flame itself produce its record on a highly-sensitive photographic plate moving at a rapid rate in a direction at right angles to the direction of the flame propagation. The speed curves obtained are all regular and very similar ; the max. speed observed in the 90-mm. tube with a mixture containing between 9 and 10 % of acetylene is 335 cm. per sec. It is suggested that the higher speeds of other experimenters are due to the inadvertent inclusion of part of the vibratory movement in the speed determination of the uniform movement. The uniform movement itself (photographs reproduced) shows slight undulations, due apparently to the resonance of the gas when ignition is effected by electric sparking, especially when there is a series of sparks. When care is taken to avoid all disturbance of the gas, ignition being effected with the aid of gas jets, the undulations are not observed. They are in any case not directly visible, but can be traced after the explosion by the appearance along the glass tubes of rings of moisture deposited at regular intervals. Similar observations were made by Neyreneuf in 1880. The frequency of the undulations is in accord with acoustical calculations. H. B.

1411. *Explosion Limits of Mixtures of Hydrogen and Chlorine.* **P. Mathieu.** (Journ. de Physique, 7. pp. 166–172, Sept.–Oct., 1917.)—The apparatus consists of a eudiometer, more than 1 cm. in diameter, over concentrated sulphuric acid. The chlorine is first introduced. Ignition is effected either (1) by induction spark or (2) by magnesium light. (1) Mixtures containing an excess of chlorine (*i.e.,* more Cl than is needed for the formation of HCl) exploded when they contained 8·1 % and more of hydrogen, and the inflammation was followed by a slight dilatation ; when hydrogen is in excess the explosions are violent, and they take place as long as the hydrogen remains below 85·7 %. (2) The limit is 9·8 % hydrogen when chlorine is in excess, and an explosion is known to have occurred in chlorine works with a mixture of 10 % hydrogen ; when hydrogen is in excess explosion occurs so long as the hydrogen percentage remains below 52·5. The reason that an excess of hydrogen makes the mixture less inflammable is probably because the heat spreads more rapidly, so that the local temperature-rise is less great. In sunlight the mixtures are not dangerous probably, unless their proportions approach the theoretical proportions. In preparing the mixtures red illumination is used, which is less dangerous than violet (Bunsen and Roscoe). H. B.

1412. *Factors Limiting the Maximum Pressures Developed in Gaseous Explosions.* **W. T. David.** (Engineering, 108. pp. 251–252, Aug. 22, 1919.)—It is well known that the max. pressures developed during the explosion of an inflammable mixture are only about half those which would be expected from theoretical calculations made on the basis that the whole of the inflammable gas is completely burnt and that the volumetric heat of the products of combustion is independent of temperature. It is, however, definitely known now that the volumetric heat of carbon dioxide and steam (of which the products of combustion are mainly composed) increases very considerably with temperature. The extent of this increase at the high temperatures developed in explosions is not known with any degree of accuracy, but it is probable that it accounts for some 50 % of the missing pressure or suppressed heat. In the present paper the suggestions which have been put forward at various times to account for the so-called "suppression of heat" are collected and discussed, and some experimental work is suggested which it is thought will throw considerable light on the problem. Section 2 deals with the energy distribution at moment of max. pressure. It seems probable that the total heat of combustion of the inflammable gas is distributed at the moment of max. pressure amongst the following categories:—Translational or pressure energy of the molecules; internal energy which may be subdivided into rotational and vibratory (this giving rise to the emission of radiation); heat loss due to conduction and radiation, unburnt gas; dissociation of the CO_2 and H_2O molecules due to high temperature; ionisation and luminescence.

Section 3 considers the internal energy of the gaseous mixture. In a gas heated by internal combustion, theoretical considerations lead to the view that the chemical energy of combination is at first transformed into internal energy of the combining molecules, but the excess of molecular internal energy will be more or less rapidly shared with the translational degrees of freedom of the molecules. The rate at which this partitioning proceeds is not known. The author's experiments on gaseous explosions seem to offer a considerable volume of evidence that the vibratory energy of the molecules at the moment of max. pressure is somewhat in excess of the equilibrium amount corresponding to the temperature. Thornton has also come to the same conclusion on theoretical grounds. Indications, therefore, are not wanting that part of the energy of combustion is, at the time of max. pressure, hidden away as an excess of molecular internal energy over and above its equilibrium amount; part of this excess would, given time, be transformed into pressure or translational energy. Some suggestions for experimental work bearing on this question are made in Section 6.

The heat loss to walls of containing vessel up to the moment of max. pressure is dealt with in Section 4. This loss is found to be of considerable practical importance, and to it must be attributed part of the missing pressure. Hopkinson's experiments are described together with the author's on coal-gas and air mixtures contained in a vessel with reflecting walls. Section 5 considers incomplete combustion and dissociation. Dugald Clerk's experiments are quoted, which seem to show definitely that all the inflammable gas is not burnt at the moment of max. pressure. Section 6 discusses measurements of internal energy of gaseous mixtures. The author opines that fairly reliable estimates of this energy can be made from the experiments suggested in the various sections. H. H. Ho.

1413. *Spectral Distribution of Energy from a Complete Radiator.* II. **I. G. Priest.** (Phys. Rev. 14. pp. 191–192, Aug., 1919. Abstract of paper read before the Am. Phys. Soc., April, 1919.)—In a previous paper [Abs. 921 (1919)] the author has proposed a new empirical formula for the radiant energy from a complete radiator ("black body") as a function of temperature and wavelength. The present paper gives a revised value of the constant D_2. The value now given is 4640, as against the earlier value of 4481 [micron degrees]$^{2/3}$. The new value of D_2 satisfies the isothermal spectral distribution data just as well as the earlier value. It was found that the isochromatic ratio data give a much more sensitive criterion for the determination of D_2 than do the isothermal distribution data for relative energy previously used. A. W.

1414. *Modification of Planck's Radiation Formula.* **W. Nernst and T. Wulf.** (Deutsch. Phys. Gesell., Verh. 21. pp. 294–337, June 30, 1919.)—A full account of the present position of the radiation formulæ and their agreement with experimental facts. For the higher values of $x (= c/\lambda T)$ the value of c is found to be 14,300 by all methods. For the lower values of x it appears that, assuming this value of c, Planck's formula must be written $E_\lambda = c(1 + a)/\lambda^5(e^x - 1)$, where a has the value 0·27 in the region $x = 25$ and falls rapidly to a value 0·001 for $x = 19$. The experimental work leading to the values of a for different regions of x is described in the paper. J. W. T. W.

1415. *On the Tensions of Saturated Vapour and the Heats of Vaporisation of Propyl Acetate at Different Temperatures.* **E. Ariès.** (Comptes Rendus, 168. pp. 1188–1192, June 16, 1919.)—The exponent n, which appears in the equation of state for fluids, has previously been determined for several substances by a method which gives rise to no uncertainty [see Abs. 1078 (1919)]. This was followed by the determination of the function T by as accurate a means as possible, so that the tension of the saturated vapour could be calculated for each of these substances from the formulæ: $\Pi = \tau^{n+2}(Z/x)$, $x = \tau^{n+1}\Gamma$.

The results obtained led to the following general form for the function Γ, namely: $\Gamma = 1 + \dfrac{(1-\tau)(\tau_0 - \tau)}{A + B\tau + C\tau^2}$, where τ_0 is the reduced temperature. The problem now consists in finding for each substance the numerical values for A, B, and C, and this is the object of the present paper. Three linear equations are obtained for three temperatures at which the vapour tensions are known, from which A, B, and C are obtained. Young's values for propyl acetate are taken at 40°, 110°, and 180°, and the values given by the formulæ are then compared with the vapour-tension data obtained by Young over an extended temperature range. The results are in excellent agreement, the greatest deviation, at 220°, being not 1/250 of the observed value. The function Γ and the three constants P_c, T_c, and n, which are the only data necessary for the determination of the vapour tension of a substance, are next shown to be sufficient for the determination of the heat of vaporisation of this substance at any temperature. Excellent agreement is again found between theory and experiment, the difference being only one gm. cal. at 240° and 278°. A table of results is given; their accuracy for propyl acetate demonstrates the great confidence with which Young's data may be received while confirming reliance in the vapour-tension formulæ. H. H. Ho.

1416. *Vapour Pressures of Benzol-Toluol Mixtures and their dependence on Temperature.* **A. Schulze.** (Ann. d. Physik, 59. 1. pp. 78–85, June 18, 1919.) —The vapour-pressure data given by Mangolt [Wiener Ber. 102. p. 107, 1893] have here been utilised for the study of the molecular constitution of toluol. Mangolt has studied the vapour pressures of pure benzol and pure toluol, and 5 mixtures of these, over an extensive temperature range by means of a static method. Mangolt's mixtures were recorded as percentage by weight, and the present author has now constructed the vapour-pressure isotherms as a function of the molecular percentage. From the new form of the vapour-pressure isothermals, the molecular constitution of both components and of their mixtures may be deduced both qualitatively and quantitatively. The conclusion is drawn from the curves that toluol undergoes association, and calculations by means of the mass law show that at 20° C. liquid toluol contains 50 % of bimolecules; at 50° C. there are still 8 %, while it is only at 60 % that toluol behaves entirely as monomolecular. The decrease in association with rising temperature may be directly deduced from the vapour-pressure curves, since their deviations from the straight line at the higher temperatures become smaller until at 60° they disappear and the curve becomes a straight line. The vapour pressures were measured at intervals of 10 deg. between 20° and 60°, and the close agreement between the theoretical and experimental values shows the validity of the theory of concentrated solutions for the benzol-toluol mixture with respect to the temperature range examined. H. H. Ho.

1417. *On the possible form of the Equation of State of Powder Gases.* **A. G. Webster.** (Nat. Acad. Sci., Proc. 5. pp. 286–288, July, 1919.)—It has been customary for ballisticians to make use of the equation proposed by Clausius, $\{p + a/T(v+\beta)^2\}(v-\alpha) = RT$, in the simplified form, suitable for the high temperatures concerned, $p(v-\alpha) = RT$. At the same time it is customary to make use of the experimental results of Mallard and le Chatelier and of Berthelot and Vieille on the specific heats, which state that C_v is a linear increasing function of the temperature. While apparently no experiments have been made on C_p, it is assumed that the difference of the specific heats is constant, as in the case of an ideal gas. The present author now examines the question of the most general form possible for the equation of state that shall permit of variablity of the specific heats, but maintain the constancy of their difference. This question does not appear to have been previously treated. H. H. Ho.

SOUND.

1418. *Variation in Sound Intensity of Resonators and Organ Pipes with Blowing Pressure.* **B[eryl] F. Love** and **M[argaret] K. Dawson.** (Phys. Rev. 14. pp. 49–58, July, 1919.)—Quantitative measurements were taken to ascertain the relation between the sound intensity of wind-blown instruments and the blowing pressure. The intensities of sound emitted by a tone-variator resonator and an organ pipe were measured by a Rayleigh resonator while the blowing pressure was noted by a water manometer. Assumptions concerning the constancy of the pitch of the sound and permanency of the sound pattern appeared justified.

The measurements showed that the intensity of the sound varied directly with the blowing pressure for the tone-variator and nearly gave a direct relation for the organ pipe. A discussion of the theory indicated that only part of the energy of the air pressure was converted into sound. E. H. B.

1419. *New Method for Absolute Determination of Frequency.* **A. Dey** with Prefatory Note and Appendix by **C. V. Raman.** (Roy. Soc., Proc. 95. pp. 533–545, July 15, 1919.)—The method for the absolute determination of acoustical frequencies here described presents several useful features. Among these are: (1) the rapidity with which very accurate results may be obtained, (2) its practical convenience and simplicity, (3) the inexpensiveness of the apparatus required, and (4) its availability for use with any of the standards of time ordinarily at hand in a laboratory, *i.e.* a seconds or half-seconds pendulum clock, a half-seconds chronometer, or even a good stop-watch. The principle on which the method is based is that of the maintenance of oscillations of sub-synchronous frequency by a periodic field of force and is applied in practice as follows:—A pendulum formed of an iron rod 0·5 cm. diam. hangs vertically from a simple wire hook suspension. A brass bob slides on the pendulum and is capable of being fixed in any desired position. The length of the pendulum is either 85 cm. or 100 cm., so that with the bob in a suitable position the free period of oscillation is roughly either one second or two seconds as desired. Underneath the pendulum is placed symmetrically a vertical bar-electromagnet which has an iron core 8 cm. long, 0·9 cm. diam., the gap between the pole and lower end of rod when in the vertical position being quite small (1 mm. or less as required). The electromagnet is excited by a current rendered intermittent by an electrically-maintained fork. With these arrangements, the rod, when hanging vertically, does not tend to be displaced from its position of equilibrium by the magnetic forces. But if the position of the bob be suitable and the pendulum be set in motion by hand with approximately the right amplitude, its oscillations are found to be vigorously maintained with a frequency which, in practice, may be very small compared with the frequency of the fork, *but is always an exact sub-multiple of it.* The rate of the pendulum can be found by comparison with any available standard of time, by coincidence of pendulums, or otherwise. Details of the method are given and the accuracy possible (5 in a million) is discussed in the body of the paper.

The appendix gives the mathematical theory of the sub-synchronous maintenance. E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1420. *Ballo-Electricity. V.* **C. Christiansen.** (Ann. d. Physik, 59. 3. pp. 280–292, July 4, 1919.)—A brief review of the researches on the production of electricity by bubbling air through liquids and a description of the condenser-ballometer of the author. In this instrument the sprayed liquid is blown against a piece of Pt-foil; the liquid dripping off is collected; the ionised air and sprayed liquid pass upward through a tube M into a condenser consisting of 19 zinc plates. The charge of the condenser and the charge remaining in the liquid are separately determined. Into the tube M is inserted the micro-condenser, which serves to determine the velocity of the ions; with this micrometer the late author could only make a few experiments. One of the incidental observations is that Jena glass, rubbed with linen, turns electro-positive when previously cleaned with tap water, and negative when cleaned with distilled water. When portions of the same liquid strike one another, both electricities are generated, but the apparent polarity may be of either sign: it depends upon the ratio of the electricity carried away with the vapour to the ballo-charge remaining in the liquid. In the case of alcohol the two charges are equal, and there is hence no apparent electrification. [See Abs. 1228 (1919).] H. B.

DISCHARGE AND OSCILLATIONS.

1421. *Under which Conditions may we Speak of an Electron-Gas?* **M. v. Laue.** (Ann. d. Physik, 58. 8. pp. 695–711, May 27, 1919.)—H. A. Wilson in 1908 dealt thermodynamically with the electrons in contact with an incandescent electrode as a gas answering to the equation of Clausius-Clapeyron. Extending the arguments of Abs. 604 (1919), the author shows that this is justified only with certain restrictions. He assumes the walls of the vessel containing the cloud of electrons to be uniform, and the material to be a conductor of electricity. The analogy between gas and a cloud of electrons can only hold when the density of the electrons is approximately constant. The deductions are made for ellipsoidal vessels.

A cloud of electrons may be regarded as a gas, but only for small vessels at low temperatures. The constant-density condition implies that in the cloud vessel the potential energy is small by comparison with the kinetic energy, and also that $pv = n\mathrm{RT}$; a special proof is given, however, that these conditions are fulfilled. The ideal gas state is approached from opposite sides by ordinary gases and by electrons. H. B.

1422. *Use of the Method of Central Fields for the Determination of the Emission Velocity of Electrons.* **H. Baerwald.** (Phys. Zeits. 20. pp. 387–389, Aug. 1, 1919.)—A theoretical discussion of the subject. A. E. G.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1423. *Comparison of Electrical Properties of Ordinary and Uranium Lead.* **P. W. Bridgman.** (Nat. Acad. Sci., Proc. 5. pp. 351–358, Aug., 1919.)—The experiments described establish that any difference between the pressure coefficient of resistance, temperature coefficient and specific resistance is at least many times less than the difference of the atomic weights of these lead isotopes. It seems indicated with a high degree of probability that the same conclusion will be found also to apply to the compressibility and thermal expansion. The results lend support to the point of view embodied in recent theories of electrical resistance, that the processes involved in electrical conduction take place in the outer part of the atomic structure. A. B. W.

1424. *Unidirectional Resistance of Crystal Detectors.* **M. J. Huizinga.** (K. Akad. Amsterdam, Proc. 21. 9. pp. 1248–1257, 1919.)—Electrolytic phenomena have been observed with the molybdenite detector and also with the iron pyrites detector; and it appears from the experiments described that the e.m.f. of polarisation is the cause of the difference of current intensity on reversal of the applied e.m.f. The characteristic curves for these detectors were compared with those of other crystal detectors and of the electrolytic detector. From the similarity of the characteristics it is concluded that with all the crystal detectors examined, though no products of electrolysis are visible, the unidirectional risistance is to be attributed to electrolytic polarisation in a film of moisture or a gas film adhering to the surface. The resistance of most of the crystal detectors employed in wireless telegraphy was found to be less than the hitherto accepted values; it was found as a rule not to exceed 100 ohms. A. W.

1425. *Inductance, Capacity, and Resistance of Coils at Radio Frequencies.* **L. E. Whittemore** and **G. Breit.** (Phys. Rev. 14. pp. 170–172, Aug., 1919. Abstract of paper read before the Am. Phys. Soc., April, 1919.)—The inductance coil used in a radio circuit may usually be considered as a pure inductance shunted by a capacity representing the distributed capacity of the coil. The pure inductance can most conveniently be determined from the values of the apparent inductance as obtained from the capacity which is required to give resonance at certain frequencies. The apparent inductance is very large at wave-lengths which are near the natural wave-length of the coil, decreasing as the wave-length is increased, until a very long wave-length is reached at which the inductance increases again slightly due to the absence of skin-effect. The pure inductance and distributed capacity of the coil may be obtained from the data used for plotting the apparent inductance curve by the use of the following formulæ:—

$$C_0 = \frac{(\Sigma C_1)(\Sigma \lambda_1^4) - (\Sigma \lambda_1^2)(\Sigma C_1 \lambda_1^2)}{-N\Sigma \lambda_1^4 + (\Sigma \lambda_1^2)^2},$$

$$L_0 = \frac{0{\cdot}2814[N\Sigma \lambda_1^4 - (\Sigma \lambda_1^2)^2]}{-(\Sigma C_1)(\Sigma \lambda_1^2) + N\Sigma C_1 \lambda^2},$$

C_0 and C_1 being expressed in micro-mfd., λ_0 in microhenrys, and λ in metres. N is the total number of observations from which C_0 and L_0 are calculated. C_1 and λ_1 are corresponding values of the capacity in series with the coil and the resonant wave-length. The assumptions made in the derivation of this least-square formula are that the error in the capacity measurement is constant, and that the percentage accuracy in the wave-length measurements is constant.

For measuring the capacity of a coil it is convenient to use a generating circuit in which the current contains harmonics of the fundamental frequency. The coil whose capacity is to be measured is connected to the terminals of a condenser and the circuit is tuned to the fundamental frequency, the capacity of the condenser being C_1. Let the circuit then be tuned to the second harmonic by the use of the capacity C_2. The capacity of the coil C_0 must be such that $C_0 + C_1 = 4(C_0 + C_2)$. While it would seem that the accuracy obtainable in this measurement would be greater if higher harmonics were used, it has been found that usually, on account of the reaction of the measuring circuit, it is better to use the second harmonic as described above. If a curve is plotted giving the capacity which it is necessary to use with the coil to obtain resonance at various wave-lengths against the square of the wave-length, this curve is a straight line which cuts the axis of capacity on the negative side of the origin. The point at which this line cuts the axis gives the value of the capacity of the coil. If the coil whose capacity is to be obtained is immersed in a liquid of dielectric constant K, the capacity C_0 of the coil is given by $C_0 = (C_1 - C_2)/(K - 1)$, where C_1 and C_2 are the capacities required to tune the coil to resonance with a certain frequency before and after the coil is immersed in the liquid. Care must be taken in this measurement to avoid the presence of solid dielectrics in the field of the coil, and the value of K must be known accurately. Examples of the use of these formulæ are given.

The capacity of a coil to earth is important in many cases. If the two condensers C_1 and C_2 are connected in series with a coil and the point of connection between the condensers is earthed, then, at resonance, the capacities of these condensers are related by the expression : $\alpha C_1 + \beta C_2 + \gamma C_1 C_2 + \delta = 0$, where α, β, γ and δ are constants of the coil and its position. For a symmetrical coil the capacity to earth is given by the expression :

$$C_0 = 4\left[\frac{C_1 C_2}{C_1 + C_2}(\text{max.}) - \frac{C_1 C_2}{C_1 + C_2}(\text{min.})\right].$$

The maximum is obtained when $C_1 = C_2$. The minimum value of $C_1 C_2/(C_1 + C_2)$ is obtained when either C_1 or C_2 is short-circuited. It is interesting to note that a coil may oscillate freely at several different wave-lengths. For a number of double-layer coils which were tested, it was found that these wave-lengths had the relation $1 : 1/k : 1/(k\sqrt{k})$, where k is a constant for the coil in question, and for a given coil had a value of 4·47.

The resistance of the coil is most conveniently measured by the resistance-variation method [Bureau of Standards, Circ. No. 74]. The resistance depends very much on the capacity of the coil. The greatest accuracy is obtainable in the use of the method when the inserted resistance is 0·6 of the resistance of the circuit. The following empirical expression was found to represent the curve between the resistance of the coil and the wave-length : $R = A + B/\left\{(\lambda^2/\lambda_0^2) - 1\right\}$, where R is the resistance at wave-length λ and A, B, and λ_0 are constants of the coil. A. W.

1426. *Electrical Conductivity of Wood.* **S. Ono** and **Y. Obuchi.** (Phys. Math. Soc. Japan, Proc. 1. pp. 223–230, July, 1919.)—Describes experiments on the conductivity of Japanese building woods, measurements being made at potentials up to 216 volts on blocks of wood 9 cm. long and 1 to 2 cm.^{2} in section. The direction of the current was along the fibres. From the results of the experiments it is concluded that the electrical conductivity of a block of wood increases with its density, and there are two different stages in the process ; in the first stage, in which the wood is comparatively dry, the rate of increase of the conductivity is very small, while in the second stage in which the wood is moist, the conductivity increases rapidly, the rate being constant. Under ordinary atmospheric conditions the wood is nearly at the transition point between the two stages. J. W. T. W.

ALTERNATING CURRENTS AND MAGNETISM.

1427. *Magnetic Storms of March* 7–8, *and August* 15–16, 1918. **C. Chree.** (Roy. Soc., Proc. 96. pp. 32–55, Aug. 1, 1919.)—The author produces additional evidence from these storms that the disturbing effect is greater at Eskdalemuir than at Kew [see Abs. 806 and 1195 (1918)]. He questions Chapman's view that "apparently all great, world-wide magnetic storms commence simultaneously, to within a few seconds, over the whole earth, although small local fluctuations may sometimes mask the commencement at particular stations" [Abs. 89 (1919)], the argument against this being that so many magnetic storms do not show the sudden commencement from which Chapman measures his times. In the two storms now discussed the sudden commencement was a prominent feature at both of the observatories considered by the author (Kew and Eskdalemuir) and the March storm also at Agincourt (Toronto) which provides a further comparison. He tabulates mean hourly values of H, D and V, for each observatory. In the case of Eskdalemuir where N. and W. force are registered instead of H and D, the N. and W. are given as well as the deduced H and D. The ranges both of the "sudden commencement" wave and of the whole storm are tabulated in addition. The curves show only a partial agreement with Chapman's general form. The hourly ranges are much greater at Toronto than at the British stations for the March storm, and the Kew curves show less disturbance than the Eskdalemuir registers, which are unfortunately incomplete, as the traces went off the sheet for some periods.

The author proceeds to determine the "magnetic activity" of the storms by Bidlingmaier's method, and discusses Chapman's arrangement of the Maxwellian integral into "self-energy" and "joint-energy" terms plus a constant. He inclines to the opinion that no simple general theory such as Chapman's is likely to add to our knowledge, and suggests that more advance is likely to be made by detailed examination of records from observatories on the same meridian, covering as large an arc as possible, and for this purpose is desirous of a new magnetic observatory in the Orkneys or Shetlands. W. W. B.

RADIOGRAPHY AND ELECTRO-PHYSIOLOGY.

1428. *New Fluorescent Screen for Radioscopy.* **P. Roubertie** and **A. Nemirovsky.** (Comptes Rendus, 169. pp. 233–234, Aug. 4, 1919.)—The fluorescent screens in use up to the present in radioscopy are based on barium platinocyanide, in which platinum plays an essential part. Platinum is a rare element, and these screens have become extremely expensive. Hence it is important to ascertain whether it is not possible to replace compounds of platinum by salts of other and less expensive metals. One of the authors discovered in 1911 that the tungstates of the magnesium group become luminescent under the action of the X-rays. They have now succeeded in preparing a new fluorescent screen by using these tungstates and notably those of cadmium. The layers used are exempt from the permanent phosphorescence which screens made from sulphides possess; they are insensible to physical and atmospheric agents, and to the prolonged action of X-rays, which deteriorates screens of platinocyanide. Their luminescence under action of X-rays being white, their radioscopic bodies appear black on the screen. This quality gives a double advantage. First, it makes the radioscopic examination easy and precise; it also enables photographs and kinematographs to be obtained. In addition, this new screen is very much cheaper than those made with platinocyanide. A. E. G.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1429. *The Periodic System and the Genesis of the Elements.* **C. Schmidt.** (Zeits. Anorg. Chem. 103. pp. 79–118, May 14, 1918.)—The periodic system has not much facilitated the systematisation of the elements, because the unjustified assumption has been made that the whole of the elements must belong to one uniform system. The author deals with the singular position of hydrogen, the rare metals, the 8th group and the anomaly of the triads in it, the relative frequency of the elements also in stars, spectroscopy, etc.

Hydrogen may be regarded as sole survivor of a past period of matter in which metallic and non-metallic properties were not yet differentiated. Going further than Baur (two generations of elements), the author would distinguish four partial systems in genetic connection, evolution taking place in accordance with two principles: the ontogenetic formation of primary members by the direct condensation of protyl, and the phytogenetic formation of the higher members by an integration process. From time to time elements have been evolved which have undergone transformation because unadaptable to the prevailing cosmic conditions. Radio-activity is a necessary consequence of this development, the ringing-out of a more general activity now confined to peculiarities in the rings of electrons. A rational nomenclature for the radio-active series is proposed. H. B.

1430. *Light-Effects in Crystals. Phototropy.* **F. Weigert.** (Zeits. Elektrochem. 24. pp. 222–237, Aug. 1, 1918.)—Phototropic changes are colour changes which are produced by illumination, and disappear again in the dark. Macdonald (1899) considered phototropy confined to crystals, but Stobbe (1908) suggested that the changes were chemical in nature, not connected with the crystalline condition, and showed that the change back is hastened by the same rays which are absorbed by the colour assumed; he hence distinguishes the "exciting" rays and the "brightening-up" rays, the latter being of lower wave-length than the former. The β-tetrachloro-α-keto-naphthalene, studied by the author with plane-polarised light, is almost colourless, but turns red-violet when excited. The excitation does not affect the axial radio $a:b:c$, and the Laue spectrogram remains unchanged, but the absorption is especially great for light entering in the $a\ b$ plane; then a band in the yellow-green appears. The solutions of the compound in ether and in benzene do not show any characteristic bands; two steps are noticeable in the ultra-violet, in the same positions as in the crystals; thus the solid and the dissolved molecules seem to be identical. Only light, of which the electric vector is vibrating in the $a\ b$ plane, is able to produce the brightening-up; the max. excitation will therefore be produced by light oscillating in the c direction, since in that case there is no brightening-up counteracting the excitation. The colouration itself is only observed in the crystal, and seems to depend upon the orientation of the closely-packed molecules in the crystal. The excited molecules expand with the heat absorption and approach one another; the absorption takes place within the molecule, which is the same in the crystal as in the solution; in the solution the orientation is lacking. The author discusses the two constitutional changes in the molecules which might account for the change, and concludes that only one of these changes would satisfy the conditions. H. B.

1431. *Limits of Gold Content for Chemical Attack in Mixed Crystals of Copper-Gold and Silver-Gold.* **G. Tammann.** (Gesell. Wiss. Göttingen, Nachr. pp. 385–425, Oct. 26, 1917. Chem. Zentrbl. ii. pp. 268–270, 1918. Abstract.) —A redetermination of the resistance limits, sometimes possible for a concentration difference of 0·001 mol. Au, especially when a distinct alteration of a uniform surface takes place. A great many reagents are studied, the classification of which is connected with the valency. The natural surface is the most resistant. H. B.

1432. *Resistance to Chemical Reagents of Ternary Copper-Silver-Gold Mixed Crystals and their Colour.* **G. Tammann.** (Gesell. Wiss. Göttingen, Nachr. pp. 378–384, Dec. 7, 1917. Chem. Zentrbl. ii. pp. 267–268, 1918. Abstract.)—The resistance limits of binary systems having been investigated, the author studies the ternary systems. Starting from mixed crystals of Ag-Cu in the ratios 1 : 2, 1 : 1, 2 : 1, he prepares alloys differing by 0·05 mol. Au between the limits 0·2 and 0·55 mol. Soft and hard modifications differ little, but the resistance-limits of ternary alloys are less definite than with binary alloys, and it is necessary to distinguish between penetrating and superficial action; with respect to the latter, ternary alloys are generally more noble than binary alloys. Various chemicals, notably strong oxidising reagents, are studied. The results of the colour observations are represented in a colour triangle. H. B.

1433. *Resistance Limits of Mixed Crystals: Vanadium-Iron and Silicon-Iron.* **G. Tammann.** (Gesell. Wiss. Göttingen, Nachr. pp. 161–179, March 7, 1917. Chem. Zentrbl. i. p. 510, 1918. Abstract.)—The resistance limit marks the composition of mixed crystals at which a sudden change in the sensitivity to certain reagents sets in. This limit is not so easily observed in V-Fe alloys, prepared by the thermit-process, as it is in Ag-Au alloys which show surface effects; but mixed crystals containing up to 0·43 molecular per cent. of vanadium are ferromagnetic, whilst richer alloys are not magnetic. In contact with acids and salts the limit lies at about 0·5 %. In the case of Si-Fe alloys, prepared from crystallised Si and mild steel, the results are less regular, because the iron turns passive in nitric acid and metal nitrate solutions. H. B.

1434. *The Ternary Systems Lead-Bismuth-Silver and Lead-Gold-Silver.* **M. Goto.** (Coll. Eng. Tokyo, J. 9. pp. 63–114, 1918.)—The eutectic point of Ag-Pb is 350°, of Pb-Au 208°; there is no ternary eutectic, and in the alloys the eutectic temperature falls continuously. Compounds are not formed; the presence of gold reduces the power of silver of holding lead in solid solution. In the case of Pb-Bi-Ag there is a ternary eutectic of 0·2 % Ag, 43·6 Pb and 56·2 Bi melting at 120°. The range of solubility of silver for the other metals is very small. H. B.

1435. *Lead-Sodium-Mercury and Lead-Sodium-Tin Alloys.* **J. Goebel.** (Zeits. Vereines Deutsch. Ing. 63. pp. 424–430, May 10, 1919.)—The author has investigated the constitutions of the Pb-Na-Hg alloys containing up to 4 % Na and up to 7 % Hg and of the Pb-Na-Sn alloys containing up to 4 % Na and 6 % Sn. In addition, hardness tests, bending tests, and crushing tests have been made on all the alloys prepared. The results show that the Pb-Na-Hg alloys containing 4 to 6 % Hg and 1 to 2 % Na possess quite favourable mechanical properties; since they corrode only very slightly they could find practical application as bearing metals. In the case of the Pb-Na-Sn alloys corrosion occurs too rapidly for them to be of any practical use. Mercury has the power of carrying the lead-sodium eutectic into solid solution, so that the alloys containing over 2·5 % Hg are homogeneous. Tin does not carry the eutectic into solution, and the heterogeneous structure of the alloys leads to electrolytic corrosion.

F. C. A. H. L.

1436. *Grain Growth in Alpha Brass.* **F. G. Smith.** (Am. Inst. Mining Eng., Bull. No. 152. pp. 1361–1388, Aug., 1919.)—Gives the results of an investigation on the effect of a previous anneal upon a following anneal in the case of a brass containing Cu 66·6, Zn 33·35%. The material for experiment was rolled with 35 % reduction after a 700° C. anneal and pieces were then annealed at 450°, 550°, 650°, 750°, and 850°. Each of the pieces thus annealed was indented under the Brinell test with a 10-mm. ball at 500, 1000, 2000, and 3000 kg. pressure and then 5 sets of 5 pieces from each of the original anneals were reannealed at 450°, 550°, 650°, 750°, and 850°. It was thus possible to observe the effect of the previous anneal on the final material with and without intermediate deformation. A large number of macrographs and photomicrographs illustrate the results, from which the following conclusions are drawn:—Brass which has received an anneal at a low temperature previous to a given deformation will recrystallise at a lower temperature and develop a finer grain than that which was originally annealed at a higher temperature; that is to say, the recrystallisation temperature and the resultant grain-size vary directly with the temperature of anneal before deformation. Upon reannealing brass without intermediate deformation there is no grain growth unless the time or temperature of the first anneal be exceeded in the second anneal. The length of time of anneal has a greater effect on resultant grain-size at low temperatures than it has at high temperatures. The ideal conditions under which typical abnormal grains are formed are that there shall be a deformation gradient which ranges from a maximum to zero within the specimen, and that the temperature of anneal before such deformation shall be identical with the final temperature of anneal. The size of the abnormal grains varies with the length of time of the last anneal, but the length of the previous anneal may also affect the size of the abnormal grains. C. O. B.

1437. *Effects Produced on the Texture of Hypo-eutectic Steel by Different Conditions of Heating and Cooling.* **A. L. Babochine.** (Rev. de la Soc. Russe de Mét. 1. pp. 691–707, 1915. Rev. de Mét. 16E. pp. 182–185, May–June, 1919. Abstract.)—An investigation of the structure of a 0·4 % C steel with 0·9 % Mn after varied conditions of annealing and normalising. Reheating to a temperature just below the Ac1 point results in the formation of granular pearlite. Taken to high temperatures an angular arrangement of ferrite and pearlite results, the boundaries between ferrite and pearlite being "corroded." There is no difference in the structure of open-hearth and Bessemer steel of the same composition when similarly treated. F. C. T.

1438. *The Determination of the Critical Points of Steel by the Differential Method.* **A. Portevin and V. Bernard.** (Rev. de Mét. 16. pp. 175–192, May–June, 1919.)—The conditions necessary for satisfactory curves are: (1) symmetrical mounting of the specimens; (2) these should be of equal dimensions with regard to (3) the hottest part of the heating chamber, which is not necessarily the geometrical centre. The complete installation used for differential pyrometry is described in too great detail for abstraction. In an appendix is described a method of determining the temperature of the carbon change-point by means of the hardening effect. The following are the diameters of the Brinell impressions obtained with a ball 10 mm. in diam. under a load of 3000 kg. The percentage compositions of the steels were as shown below:—

	C.	Si.	Mn.	Ni.	Cr.
Carbon steel	0·30	0·45	0·88	—	—
Ni-Cr steel..............................	0·30	0·14	0·70	3·14	0·60
Air-hardening Ni-Cr steel	0·24	0·23	0·42	4·10	1·28

DIAMETER OF BRINELL IMPRESSIONS.

Temperature of Quenching.	Cooled in Air.	Quenched in Oil.	Quenched in Water.
	I. Mild carbon steel.		
650°	4·48	4·48	4·45
675	4·52	4·50	4·43
700	4·53	4·47	4 44
725	4·53	4·53	4·46
750	4·55	4·50	4 24
775	4·41	3·53	2 96
800	4·42	3·18	2·67
825	4·36	2·97	2·63
900	4·19	2·84	2·58
	II. Nickel-chrome steel.		
650°	4·11	4·11	4·02
675	4·05	4·05	4·07
700	4·14	4·15	4·11
725	3·87	3·39	2·73
750	3·59	2·85	2 69
825	3·57	2 83	2·71
900	3·59	2·80	2·77
	III. Air-hardening nickel-chrome steel.		
650°	3·81	3·80	3·79
675	3·80	3·81	3·81
700	3·76	3·75	3·71
725	3·45	3·29	2·95
750	2·91	2·76	2·68
825	2·79	2·77	2·70
900	2·79	2·78	2·69

F. C. T.

1439. *Graphilisation of White Cast Iron on Annealing*. **P. D. Merica** and **L. J. Gurevich**. (Am. Inst. Mining Eng., Bull. No. 151. pp. 1063–1072, July, 1919). Bureau of Standards, Technol. Paper, No. 129. [12 pp.] Washington, 1919.)—An investigation on the temperature at which graphitisation of white cast iron commences, *i.e.* the highest temperature at which chill castings such as wheels can be annealed without destroying the chilled tread. The mean composition of the material used was CC, 3·67 % ; Mn, 0·58 %; Si, 0·6 %; S, 0·18 %; P, 0·33 %. Annealed for 6 hours graphitisation commences about 820° C., while after 48 hours it is appreciable at 700°. The presence of graphite facilitates further decomposition of carbide. At very high temperatures near the melting-point a certain amount of graphite passes back into the combined form. Graphitisation takes place above 700° directly from the solid solution. A typical series of results is summarised :—

Duration of Annealing.	Graphite per cent. Temperature of Annealing. 700°	750°	800°	850°	900°	1000°	1100°
6 hours ……	0·05	—	0·09	0·40	2·74	3·44	3·12
48 hours …	0·20	0·35	2·90	3·21	3·30	—	—

F. C. T.

1440. *Dissociation Pressures of Some Nitrides.* **R. E. Slade** and **G. I. Higson.** (Chem. Soc., J. Trans. 115. pp. 215–216, March, 1919.)—Equilibria of the type 2 M + $N_2 \rightleftarrows$ 2 MN, where M signifies three equivalents of a metal, are determined in an electric furnace, a platinum tube, 2 cm. in diam., heated by currents of 300 or 400 amps. at 3 or 4 volts [see Abs. 687 (1918)]. A small quantity of the metal is heated to a known temperature, nitrogen is introduced and the fall of pressure is measured; nitrogen is then pumped out and the equilibrium determined from the low-pressure side; the heat of nitride formation Q_0 at absolute zero is calculated by Nernst's heat theorem. In the case of vanadium the equilibrium pressures were about 0·2 and 1·5 mm. at 1203° and 1271°, yielding Q_0=79,200 or 77,200 cals. With boron the velocity of the reaction at 1100° was too low for determination; at 1240° the pressure seemed very slowly to approach 9·4 mm., but the boron attacked the Pt-tube; Q_0 was probably 69,000. Tantalum seemed to form the nitride TaN (not Ta_3N_5); the pressures were 0·4 or 0·5 mm. and 1·3 to 1·2 mm. at 1170° and 1308°, which would yield Q_0=74,700 to 75,500 and 79,900 to 82,800 cals.

H. B.

1441. *Equilibria in the Reduction of Oxides by Carbon.* **R. E. Slade** and **G. I. Higson.** (Chem. Soc., J. Trans. 115. pp. 205–214, March, 1919.)—The equilibria investigated are of the type: metal oxide + carbon $\rightleftarrows$ monoxide + metal, or metal-oxide + metal carbide $\rightleftarrows$ carbon monoxide + metal. A small quantity of the metal is heated in a vacuum in an unglazed Berlin porcelain boat within Slade's platinum-tube furnace; some CO is admitted until the pressure exceeds the equilibrium pressure; the reaction proceeds from right to left and CO is absorbed until equilibrium is attained; some CO is then removed, and equilibrium re-obtained from the other side. The calculations are based on Nernst's heat theorem. Experiments are made with vanadium and tantalum (less than 0·1 gm. of each) and chromium (about 0·5 gm.). In the case of vanadium (containing 4·6 % C.) the equilibrium pressure at 1340° was found to lie between 1·2 and 1·7 mm., the temperature at which CO at 1 atmo. would reduce vanadium oxide would hence be 1827° and the heat of the oxidation V + O=VO + 111,000 cals. (approximately) at 20°. In the case of tantalum the equilibrium pressure was 0·1 mm. at 1270°, The chromium (not quite free of Al) gave in successive tests at 1292, 1889, 1292° the pressures 6·2, 9·2, 4·4 mm.; thus the pressure was smaller after heating to 1889°, which may be due to there being a transition point of Cr between these two temperatures. Above 1200° chromium is volatile. H. B.

1442. *Ionisation of Gases during Chemical Reaction.* **A. Pinkus.** (Helvet. Chim. Acta. 1. pp. 141–145, Oct. 1, 1918. J. Chim. Phys. 16. pp. 201–227, July 31, 1918.)—The author studies two gas reactions in a large glass globe, provided with electrodes of Pt-Ir joined to an electrometer, under gas pressures varying from 0·25 to 0·5 atmo. Mixtures of nitric oxide and oxygen did not give rise to any ionisation; mixtures of nitric oxide and chlorine did not do so either, except when chlorine was in excess; in this latter case the compound $NOCl_2$ was probably formed as an intermediate product. Thus the possibility of ionisation would have been demonstrated; but further experiments are desirable. H. B.

1443. *Stream Potentials and Colloid Stability.* **H. R. Kruyt.** (Kolloid. Zeits. 22. pp. 81–98, March, 1918.)—The stream potential, the p.d. set up when an electrolyte is forced through a capillary, has been little investigated. The author makes use of the arrangement of A. Grumbach, but adopts KCl solution, not pure water, as reference liquid. The solution is passed under constant pressure through the capillary from one vessel into another, silver electrodes being used, and the author plots the values of E/P (E in microvolts, P in cm. Hg) against concentration (μ mol. per litre). The potential becomes constant in the course of a few days. The curves fall rapidly with increasing concentration of the KCl, $BaCl_2$, $AlCl_3$, and this influence increases with the valency of the kation, 0·8 μ mol. (0·1 mgm. per litre). $AlCl_3$ completely reduces the stream potential from 350 to 0. More important than the stream potential itself is the charge of the glass walls which (Helmholtz) is proportional to the product of the stream potential and the electrolytic conductivity. At very low concentrations the electrolyte raises the contact potential, at higher concentrations it lowers the potential. Elissafoff had noticed a similar reversal in the electro-osmotic transport. Adsorption is important as in Powis' experiments [see Abs. 845 (1916)] on the influence of the chlorides mentioned on the transport of oil emulsions. In pure water OH-ions are probably adsorbed, but the limit changes at the isoelectric point (equilibrium between $H^{\cdot}$ and OH') do not agree with Perrin and R. Ellis. The changes in the contact potential may account for the peptonising action of electrolytes in very dilute colloidal solutions and for the great influence of small quantities of electrolytes upon the stability of colloidal systems. H. B.

1444. *Electric Potentials of Alloys: Antimony-Bismuth, Lead-Thallium, Thallium-Antimony.* **E. Bekier.** (Chemik. Polski, 15. pp. 119–131, 1917). Chem. Zentrbl. 1. pp. 1000–1001, 1918. Abstract.)—The measurements were made with H cells by Poggendorff's compensation method. The behaviour of Bi-Sb alloys in potassium antimonyl tartrate suggests the existence of a continuous series of mixed crystals. In Tl-Pb alloys (electrolyte thallous chloride) mixed crystals exist over the range 100 to 12 % Pb. Alloys of Tl-Sb, electrolyte TlCl, show the Tl potential so long as the Sb percentage does not exceed 16·4; free thallium seems also to occur in the alloys corresponding to $SbTl_4$ and $SbTl_3$; alloys with from 16·49 to 90 % Sb have the constant potential of a compound. With more than 90 % Sb the potential falls off rapidly. H. B.

1445. *Photochemical Cell with Complex Cyanides.* **S. Iimori.** (Tokyo Chem. Soc. J. 39. pp. 1–13, 1918.)—Platinum electrodes are immersed in solutions of complex cyanides (K-Ni, or K-Pt), and one of the electrodes is exposed to light. It turns positive, whilst it was negative in the potassium ferrocyanide cells previously studied by the author. The current, moreover, decays quickly when the circuit is closed through high resistance, and the author concludes that its e.m.f. is not, with these complex cyanides, of the same nature as with other solutions. H. B.

1446. *The Phenomenon of Electrical Supertension.* II. **A. Smits.** (K. Akad. Amsterdam, Proc. 21. 8. pp. 1106–1111, 1919.)—In the first communication on this subject the supertension of hydrogen was considered which appears at unattackable electrodes on the passage of an electric current. The present paper discusses the phenomenon of supertension at the generation of hydrogen which occurs when metals act on water or on solutions of acids without the aid of an electric current, *i.e.*, without entrance of electrons from outside. From considerations given in detail, it is shown that when hydrogen generates at a metal whose potential is baser than that of the hydrogen electrode, then the hydrogen does not present the phenomenon of supertension. Cases are described where the hydrogen presents supertension, and diagrams are given whereby this may be evaluated. H. H. Ho.

1447. *Some Applications of the Variation of Hydrogen Overvoltage with the Pressure.* **D. A. McInnes** and **A. W. Contieri.** (Nat. Acad. Sci., Proc. 5. pp. 321–323, Aug., 1919.)—In a previous communication [Abs. 973 (1919)], it was shown that the hydrogen overvoltage at a given electrode can at low current densities be expressed with a considerable degree of approximation by the equation $2FE = 3RT\nu/pr$, in which E, r, p, and ν are, respectively, the overvoltage, the radius of the hydrogen bubbles, the pressure, and the surface tension. The value of r was found experimentally to be independent of the pressure, and a plot of the variation of the overvoltage with the pressure was found to follow, very nearly at least, the hyperbola required by the above expression.

The present paper deals with the investigation of some chemical processes, in which hydrogen overvoltage is intimately involved, to see whether changes in these processes, produced by variations in the external pressure, are also in the direction predicted by the theory. Three such processes investigated were (1) the corrosion of metals in acid solutions, (2) reduction in acid solutions by metals, and (3) the electro-deposition of metals. Watts and Whipple have found that, contrary to statements in the chemical literature, a decrease of the external pressure will produce a decrease of corrosion of metals in acids. These workers, however, attribute the decreased corrosion to the absence of air in the solutions which were under reduced pressure. As it seemed probable that the effect is mostly due to an increase in the overvoltage with decreased pressure, their experiments were repeated, taking care to exclude oxygen from the acid. A table of results is given for Zn, Fe, and Cd, and shows that the effect of decreased pressure on the corrosion of the first two of these metals is in the direction predicted. No bubbles of hydrogen were observed to leave the surface of the cadmium, so no change of overvoltage, and therefore no change of the corrosion with the pressure, is to be expected. In case 2, a decrease of pressure is found to increase the overvoltage, and thereby increase the speed and efficiency of a large class of reductions. If hydrogen were evolved at a kathode at its reversible potential under all conditions, no metal higher in the electromotive series than hydrogen could be deposited electrolytically from an aqueous solution. Due to hydrogen overvoltage, however, it is possible to obtain deposits with metals as high in the series as zinc. The data obtained indicate that the increase of hydrogen overvoltage produced by a decrease of pressure is accompanied, in the case of the deposition of zinc, by an increase in the efficiency of the deposition.

H. H. Ho.

1448. *Photolysis and Electrolysis.* **E. Baur.** (Helvet. Chim. Acta, 1. pp. 186–201, Oct. 1, 1918.)—According to Trümpler and Hatton, uranyl sulphate and formate behave as if they contained, after decomposition by light, both a higher and a lower uranium oxide, in which the valency would be 8 and 3; such solutions evolve both oxygen and hydrogen. Photolysis would then be a molecular electrolysis under the influence of a molecular potential difference set up by the action of the light, and the chemically-active compounds would act as kathodic or anodic polarisers. In the decomposition of Eder's eosin solution, which is particularly studied next to the uranyl salts, there is kathodic reduction of mercuric to mercurous chloride with chlorine liberation and anodic oxidation of oxalic acid to carbon dioxide. In the experiments the source of radiation was either the sodium line 589 $\mu\mu$, or the blue mercury line 435 $\mu\mu$, the fluorescent mercury line 253·6 $\mu\mu$, or γ-rays (0·012 $\mu\mu$). Calculating for these radiations, the e.m.f. E on the assumption that only one energy-quantum is absorbed, the author finds, in the order stated: $E = 2{\cdot}4$, 3·2, 5·5, about 100,000 volts.

H. B.

1449. *Electrolysis of Fused Sodamite and Potassamide.* **L. Wöhler** and **F. Stang-Lund.** (Zeits. Elektrochem. 24. pp. 266–270, Sept. 1, 1918.)—Though sodium amide has become technically important since it serves for the condensation in the synthesis of indigo dyes and as an intermediate product in the preparation of cyanides, its properties were imperfectly known. The authors describe an electrolytic cell for the preparation of the amides in which a nickel crucible, standing on wire gauze, contains sodium metal over which ammonia is passed. In the same cell the properties and electrolysis of the amides are studied. The melting-points of sodamite and potassamide are found to be 210° and 338° C. respectively, instead of 149° to 155° and 270° to 272° C. previously given by Titherley. Both the fused amides are conductors ionising according to $\mathrm{NaNH_2} \rightleftarrows \mathrm{Na^{\cdot}} + \mathrm{NH_2'}$. At the anode $6\mathrm{NH_2}$ passes into $4\mathrm{NH_3} + \mathrm{N_2}$. The voltages required for the decomposition of the Na and the K amides are respectively 0·7 and 0·87; the specific conductivities are at 210° (Na amide) 0·593 reciprocal ohm, and at 240° (K amide) 0·389. Analytical methods are discussed; chlorine and iodine form substituted ammonia with the amides; hydrazine (supposed to be formed by the electrolysis) is not produced by the electrolysis, nor by the action of the halogens.

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